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ABSTRACT

Presented are approximately 100 energy-related lessons for elementary school students. Among the topics addressed are the importance of energy, future energy sources, energy conservation, forms of energy, and electricity. Most activities relate to science and/or social studies and include illustrated handouts to duplicate for students. Listed in each lesson plan are objectives, subject area, notes to the teacher, and teaching suggestions. (WB)

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ENERGY

ED200407

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PENNSYLVANIA'S ENERGY CURRICULUM FOR THE PRIMARY GRADES

SE 034 450

Pennsylvania Department of Education 1980
Funds Provided by Governor's Energy Council

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Pennsylvania Department of Education
P.O. Box 911, 333 Market Street
Harrisburg, PA 17108

I.

The Sun: Our Prime Energy Source

Grade Level: K-3

Disciplines: Health, Language Arts, Physical Education

Objectives:

The student will recognize that people get energy from foods.
The student will discuss how food helps him/her work and play.
The student will recognize that all animals need energy from food to do work.
The student will trace food energy to the sun.

Suggested Time: 2-20 minute periods

Materials Needed:

Puppet of Energy Ant*, Energy Ant filmstrip #1*, apple, picture of sun, labeled cards, string

Teacher Notes:

This activity illustrates the flow of energy through the food chain which provides the ability for people to think, work, and play. Food can be thought of as fueld for the body, just as gasoline is fuel for an automobile. It is important to establish that the energy of our bodies comes originally from the sun through the food chain.

Teaching Suggestions:

Show Energy Ant filmstrip #1. Introduce an Energy Ant puppet to the students as an example of an organism that is like us in that it, too, needs plenty of energy to keep it going. Ask: "Where does Energy Ant get its energy? Where do we get ours?" Show them an apple. Ask: "Where does the apple get its energy?" (Or "How did it grow?") Show a picture of the sun to illustrate that it is the source of energy for plants which provide food for animals and people. Discuss all the things people can do because of the food they eat.

Using pupils to represent the components, construct a model of a food chain or food web. Prepare cards with labels such as sun, green plants, grasshopper, frog, bird, snake, fish, cow, person. Make as many components as you like, but always include sun, green plants, a plant eater (herbivore), a meat eater (carnivore), and a person. Assign the cards to pupils. Have the two pupils representing the sun and green plants hold a length of string between them. Now connect one of the herbivores to the plants; follow this with a carnivore linked to the herbivore. Continue linking the components with string. As more and more components are added, cross-links between the herbivores and carnivores begin to be evident and the food web concept is developed. Ask: "Why is the sun necessary for all life?"

Additional Activities:

Discuss what happens when we do not get the proper amount of food to eat, or do not get the right kinds of food. (Feel tired, sluggish, lazy, etc.) Compare this with a machine that does not get the right kind of fuel. Bring out the fact that children in many parts of the world do not have enough food to eat.

*Available from National Audiovisual Center
Washington, DC 20409

Adapted from a module
prepared by Donna Langley,
Uniontown School District

Grade Level: K-3, 4-6

Discipline: Science, Social Studies

Objectives:

The students will trace the steps required to bring a hamburger to the table.

Suggested Time: One class period

Materials Needed: Activity sheet, Breaking the Food Chain

Teaching Suggestions:

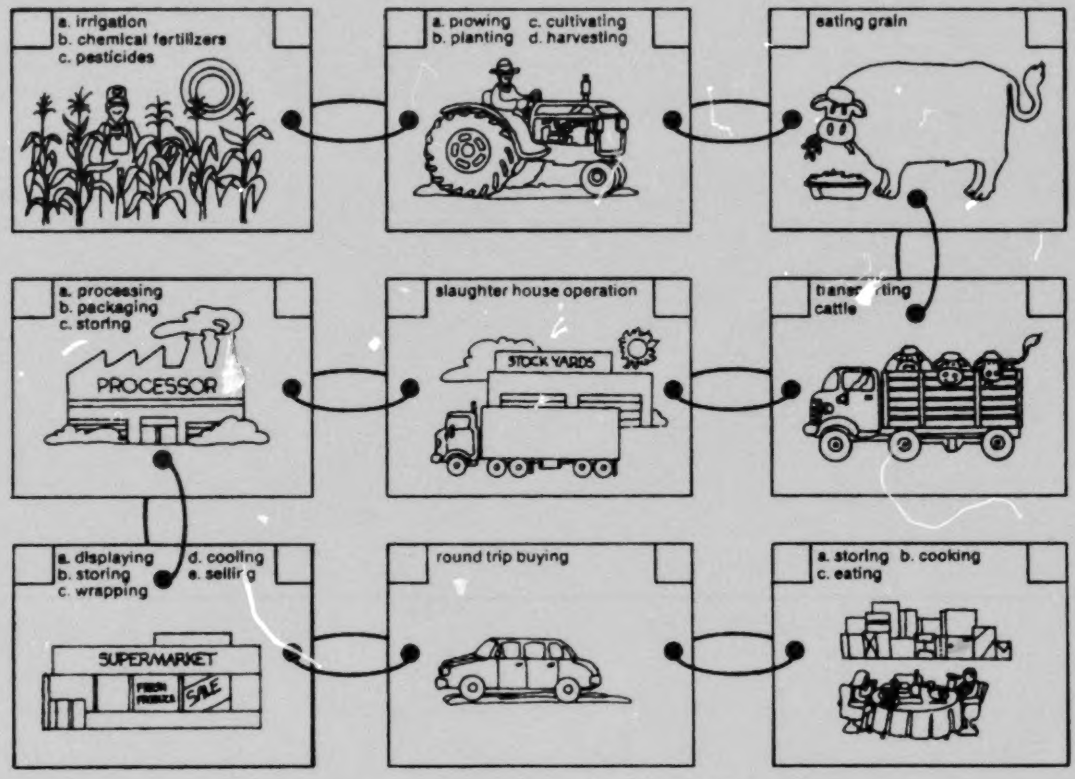
Have students complete the activity sheet. Discuss results.

BREAKING THE FOOD CHAIN

It's so easy to go to the supermarket and pick up a gallon of milk or a pound of hamburger that we don't stop to think about the energy it takes to produce the food we eat. The growing of crops and the processing, transporting, packaging, storing, marketing, and preparing of food - all use large amounts of energy resources. Let's take a look at these links of the "food chain."

ENERGY ALONG THE FOOD CHAIN

On the diagram below, trace the steps required to bring a hamburger to your table. Number the steps in the left hand box and put an X in the right hand box at each step that uses *fossil fuel energy resources* (coal, petroleum, natural gas).


a. irrigation
b. chemical fertilizers
c. pesticides
a. plowing
b. planting
c. cultivating
d. harvesting
eating grain
a. processing
b. packaging
c. storing
PROCESSOR
slaughter house operation
STOCK YARDS
transporting cattle
a. displaying
b. storing
c. wrapping
d. cooling
e. selling
SUPERMARKET
FRESH FRUITS
SALE
round trip buying
a. storing
b. cooking
c. eating

FOLLOWING THE LINKS

In the spaces below, put the numbers of the steps of the food chain that are required in the production of:

a quart of milk ____________

a loaf of bread ____________

a can of tomato soup ________

____

tomatoes from your garden ____________

a TV dinner ____________

fresh produce from a farmer's stand ________

____

Grade Level: 4-6

Discipline: Science

Objectives:

The students will recognize that the sun is a source of energy and heat.

Suggested Time:

30 minutes class time, 1 hour 30 minutes to check and record results

Materials Needed:

2 styrofoam cups, 2 thermometers, cold water, record sheet, Our Big Heater coloring sheet

Teacher Notes:

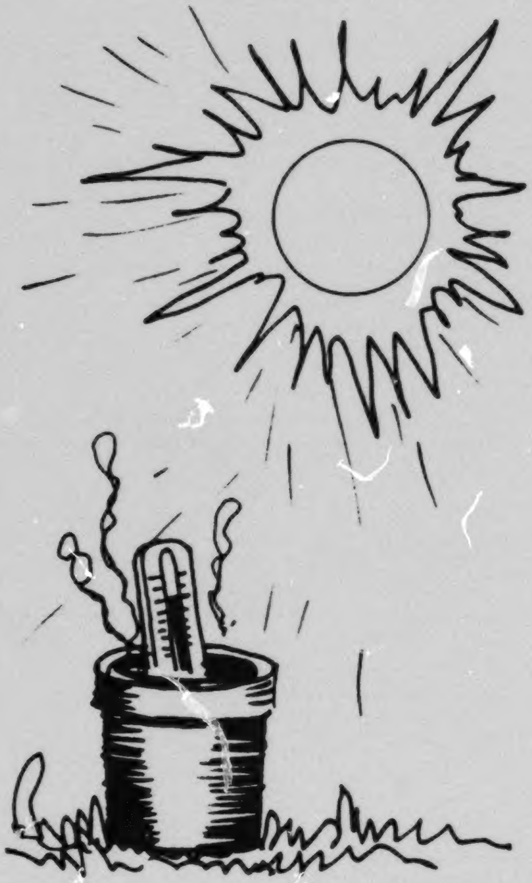
The children should have a basic understanding of numbers to 100. They should know that the higher the mercury on a thermometer, the warmer the temperature. A day with hot sun is necessary to show clear results.

Teaching Suggestions:

Ask: "How many ways can you think of to get warm?" List responses on board. Ask: "Can the sun really make things warmer? How do we measure how warm something really is?" Fill two cups with exactly the same amount of cold water and put a thermometer in each cup. Choose two children to read the thermometers and record the temperature on the individual record sheets which follow. Write "Sun" on one cup and put it in the sun. Write "Shade" on the second cup and put it in the shade. In 15 minutes check the temperature in each cup and record on the record sheets. Check and record temperatures again in 30 minutes and 60 minutes. Discuss findings at the end of 60 minutes. Lead children to draw the conclusion that the sun warmed the water and is thus a source of heat and energy. Discuss how the heat from the sun warms the ground, air, water, and everything its rays touch. Have children color the sheet "Our Big Heater."

Adapted from an activity
by Barbara Lanza, Edgeworth
Elementary School, Sewickley, PA

SUN



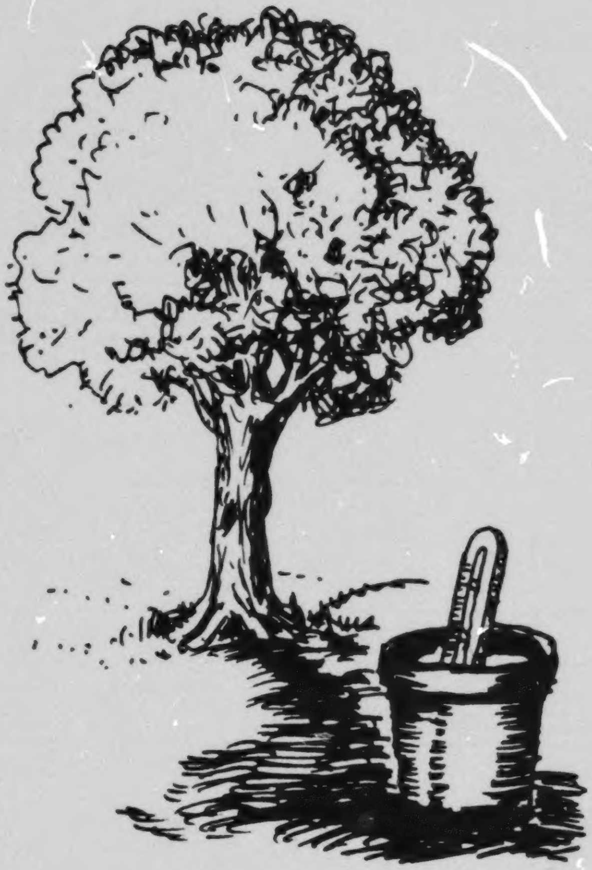
We put water in a cup _______°

15 minutes _______°

30 minutes _______°

60 minutes _______°

SHADE



We put water in a cup _______°

15 minutes _______°

30 minutes _______°

60 minutes _______°

RECORD SHEET

OUR BIG HEATER

Grade Level: 4-6

Disciplines: Science, Art, Language Arts

Objectives:

The student will be able to list some of the primary sources of energy that are traceable to the sun.
The student will be able to explain how some of the primary sources of energy are related to the sun.

Suggested Time: 40 minutes.

Materials Needed:

Samples or pictures of the following: sun, fossil fuels (coal, oil, natural gas), falling water, wind, tides, green leaves, green plants, wood, food.

Teacher Notes:

The sun, as the "Mother Star" of our solar system, is the source of almost unbelievable amounts of energy. The sun releases energy into space in the form of rays or waves of radiation. Visible light, heat, and radio waves pass through the earth's atmosphere in just the right amounts necessary to sustain life.

The sun heats the land and the oceans, and creates the currents, the wind, and the waves. It evaporates water, providing the energy for the earth's water cycle. The water that falls as rain feeds the rivers and the streams that turn water wheels and turbines of hydroelectric plants. Radiant energy is changed to stored chemical energy by the process of photosynthesis that takes place in the cells of green plants. It is this chemical energy that is stored in coal, oil, and natural gas, as well as in the food that the plants produce.

Teaching Suggestions:

Pass around several samples of food (candy bars, peanuts, apples, oranges, canned food, cereal, etc.) and discuss what they do for our bodies. (Among other things, they provide energy for our bodies.) Indicate that they contain stored chemical energy for our bodies. Ask: "Where did they get the chemical energy?" Attempt to lead them into the concept that the plants involved used the sun's energy in the production of food.

Then examine samples (or pictures if samples are not available) of the fossil fuels and wood. Discuss how these might be related to the sun, reminding them that the fossil fuels are considered to be our major energy source at the present time.

Then examine pictures of rain, falling water, tides, and wind action and attempt to determine how they are caused by solar energy.

After making a list of these energy sources that are directly related to solar energy, have the students write a sentence or two (with teacher guidance where necessary) explaining the relationship of each to the sun. Also have the students make small drawings related to each of these energy sources. A bulletin board display could be developed from this, with pieces of yarn stretching from a big yellow paper sun to each of the pictures.

Additional Activities:

Demonstrate the water cycle:

A. Examine terrariums containing condensation. Discuss its origin.

B. Allow the steam from a water kettle to hit the bottom of a metal tray or can of ice cubes. Observe the "rain". For the sake of safety, this should be conducted by the teacher.

Show the effect of sunlight on plants:

A. Have two similar plants. Cover one and allow other to be exposed to sunlight for a few days. Observe any differences between the plants.

B. Cover some leaves on indoor plants or outdoor trees with envelopes or paper bags. Observe any differences between covered and uncovered leaves after a few days.

Grade Level: 4-6

Disciplines: **Science and Social Studies**

Objectives: The students will be able to trace energy sources to the sun.

Suggested Time: One class period

Materials Needed:

Transparency "It All Starts With the Sun" and Activity Master, both of which follow

Teacher Notes:

Most of the energy in our solar system comes originally from the sun. Primary sources of energy are those from which energy can be directly released and used. Secondary sources of energy are produced as a result of energy released from primary sources. Primary sources of energy include the fossil fuels (coal, peat, oil, oil shale, and natural gas); solar energy in its various forms (radiant energy, wind, tidal, and wood); energy from the earth (geothermal); nuclear energy; and falling water. Electricity is a secondary energy source; some primary source must be used to produce it. Fossil fuels and nuclear fuels are non-renewable--once they are used, they are gone. Solar, tidal, falling water, wood, wind, and geothermal energy are renewable forms of energy.

Primary sources of energy are used to run factories, heat homes, fuel vehicles, and generate electric power. The fossil fuels are also important in the manufacture of plastics, fibers, detergents, medicines, and other products, and coal is used to make coke for the steel industry.

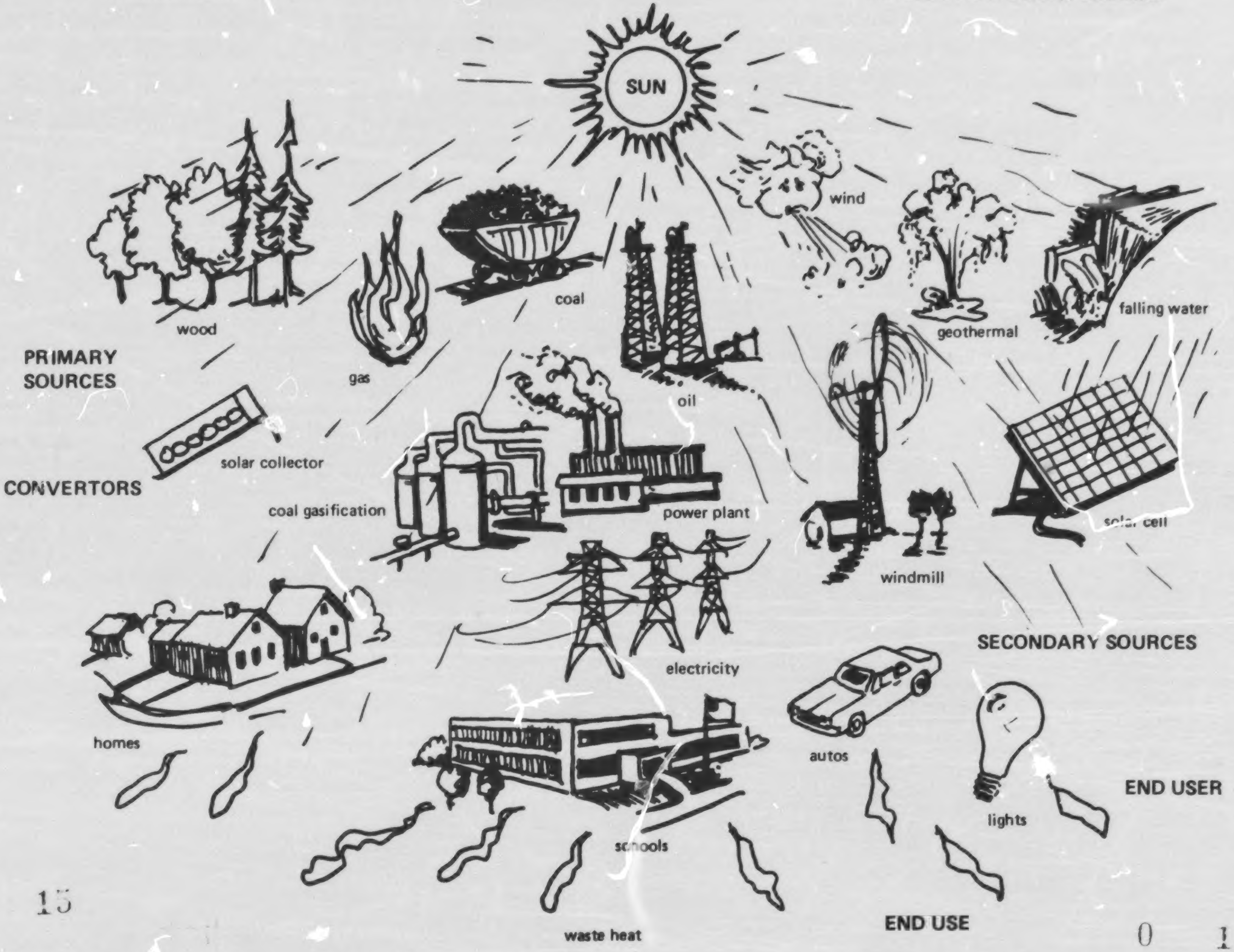
Energy sources usually do their work through the use of some sort of converter which changes their energy into a more useful form. For example, when coal is burned to make electricity, the converters are turbines located in a power plant. A solar panel on a home converts the sun's energy to heat the home. In the conversion process, some energy is wasted, and this wasted energy usually is in the form of heat, which is released to the atmposphere.

Teaching Suggestions

This activity can be used with the transparency to show the flow of energy from the sun through primary sources and converters to its end use. The worksheet can be completed individually as seat work or as an evaluation of the students' knowledge of energy sources. It would make an excellent board game used with teams of students and points being scored for correct answers.

TRANSPARENCY

IT ALL STARTS WITH THE SUN


SUN
wood
gas
coal
oil
wind
geothermal
falling water
PRIMARY SOURCES
solar collector
CONVERTORS
coal gasification
power plant
windmill
solar cell
electricity
SECONDARY SOURCES
homes
schools
autos
lights
END USER
waste heat
END USE

ACTIVITY MASTER

IT ALL STARTS WITH THE SUN

Where do each of these fit in the Flow of Energy from the Sun?

Wind Sun Fossil Fuel Coal Peat Wood Oil Electricity

Natural Gas Falling Water Fertilizer Power Plant Light bulb

Geothermal Hydroelectric Plant Solar Cell Solar Panel Tides

Turbine Automobile Train Heat for Home Heat Pump Oil Shale

Waste Heat

Original Source	Primary Source	Convertor	Secondary Source	End Use (User)

ACTIVITY MASTER

IT ALL STARTS WITH THE SUN

ANSWER SHEET

Where do each of these fit in the Flow of Energy from the Sun?

Wind Sun Fossil Fuel Coal Peat Wood Oil Electricity

Natural Gas Falling Water Fertilizer Power Plant Light bulb

Geothermal Hydroelectric Plant Solar Cell Solar Panel Tides

Turbine Automobile Train Heat for Home Heat Pump Oil Shale

Waste Heat

Original Source	Primary Source	Convertor	Secondary Source	End Use (User)
Sun	Wind	Power Plant	Electricity	Fertilizer
	Fossil Fuel	Hydroelectric Plant	Heat	light bulb
	Falling Water	Solar Panel		Automobile
	Geothermal	Solar Cell		Train
	Coal	Turbine		Waste Heat
	Peat	Heat Pump		
	Wood			
	Oil			
	Natural Gas			
	Tides			
	Oil Shale			

II.
The Importance of Energy

Grade Level: 1

Discipline: Language Arts, Social Studies

Objectives:

The student will be able to discuss how machines and labor-saving devices use energy to do jobs that once had to be done by muscle power alone.
The student will recognize that these machines usually use energy from dwindling fossil fuels.

Suggested Time: 20 minutes

Materials Needed:

Filmstrip #1 from "A Powerful Friend," worksheets that follow

Teacher Notes:

In the late 1950's and early 1960's we became dependent on many energy-intensive devices to enhance our lifestyles. Abundant fossil fuel sources and cheap energy made this possible. Today we are becoming aware that our fossil fuel energy sources are finite and supplies are dwindling. As shortages occur and energy prices rise, a knowledge of how we use energy in our lives is important so that we can be selective in how we conserve. This activity is designed to help young children become aware of familiar items that use energy to perform certain tasks, how people did these tasks in the past, and how people might do these tasks in the future.

Teaching Suggestions:

Show filmstrip #1 from "A Powerful Friend." Ask: "What was the boy doing to use energy? How do children get energy? Which does more work, a mule or a tractor?" Discuss how machines do more work than one person can, but that energy from fossil fuels is used when machines do work, while humans and animals use muscle energy.

Have children complete worksheets on energy users.

Additional Activities:

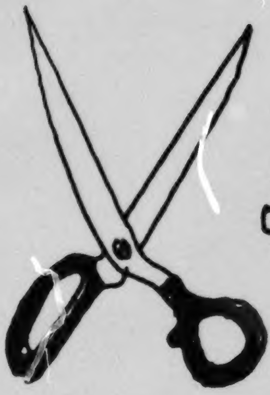
Make a bulletin board showing machines and appliances contrasted with people working. Use student art work and/or pictures from magazines.

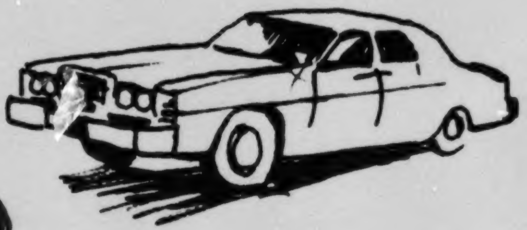
Provide pictures of different toys, including ones that run by electricity or batteries. Have the students select the toys that use the least amount of energy. Have them make up a wish list (or a Christmas list) of toys which do not use electricity. An extension of this activity could be to discuss with the children what the toys are made of, pointing out that plastic toys are made from petroleum products.

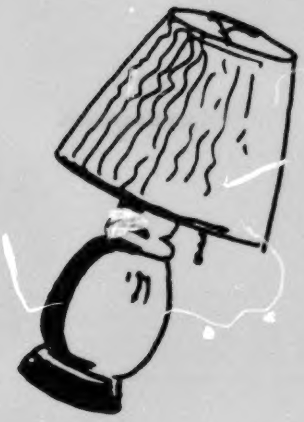
*Available from
Edison Electric Institute
Instructional Dynamics, Inc.
450 E. Ohio Street
Chicago, IL 60611

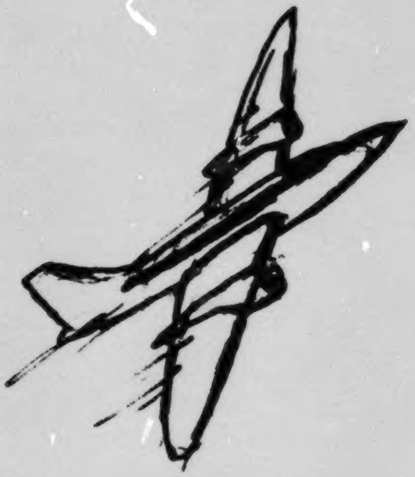
Adapted from a module
prepared by Cindy Maizlik,
Center Grande Elementary
School

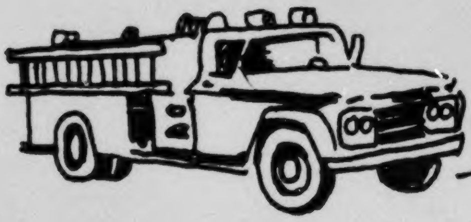
PUT A SUN ☼ AROUND THE THINGS THAT USE ENERGY OUTDOORS

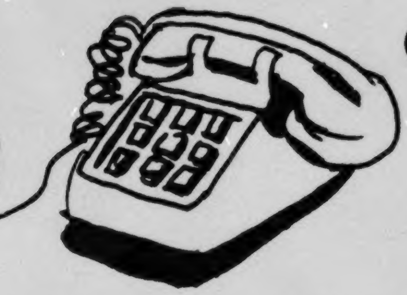


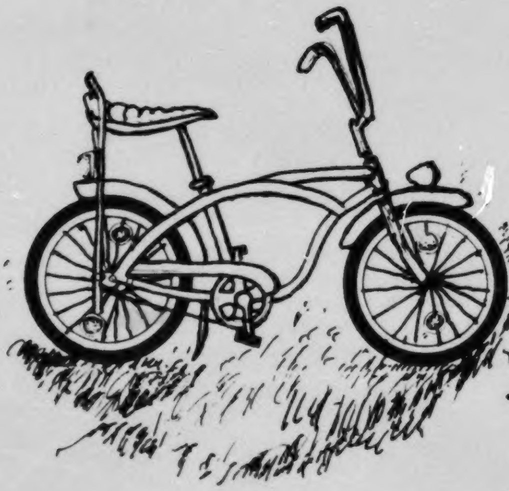


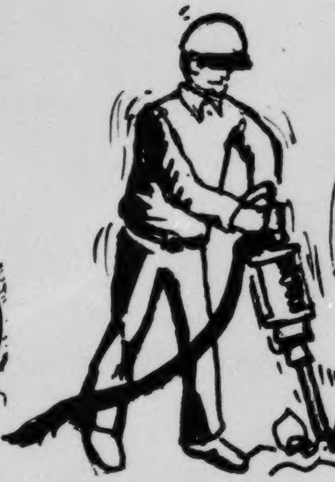


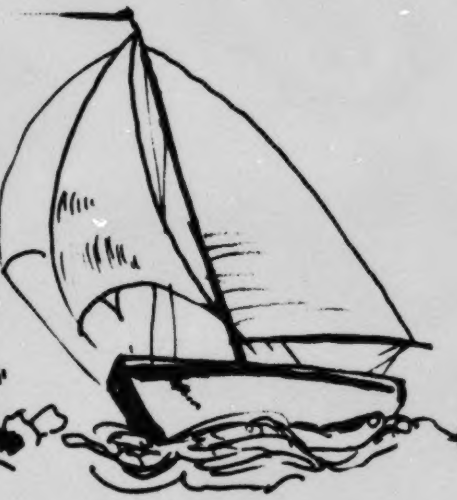




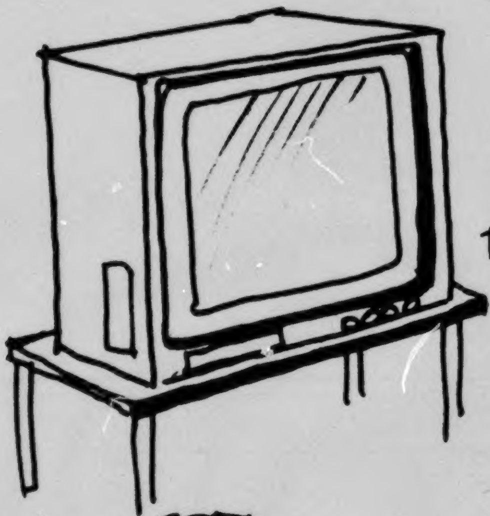


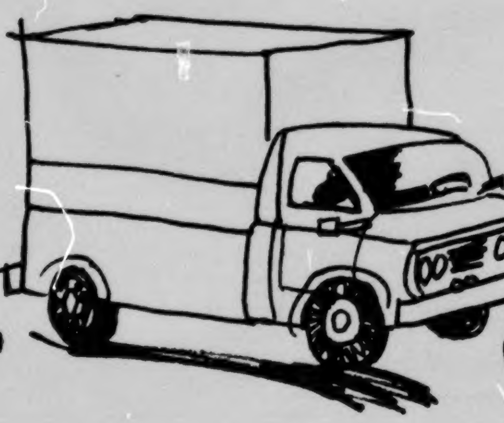


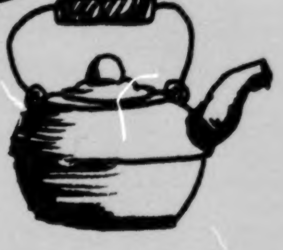


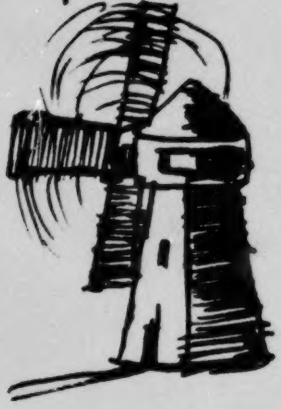


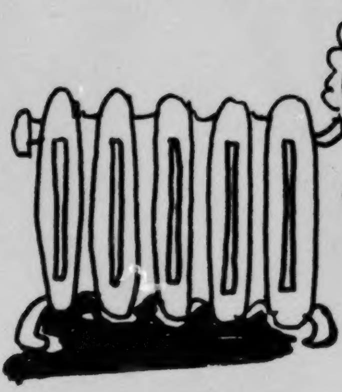
DRAW A HOUSE ⌂ AROUND THE THINGS THAT USE ENERGY IN YOUR HOME

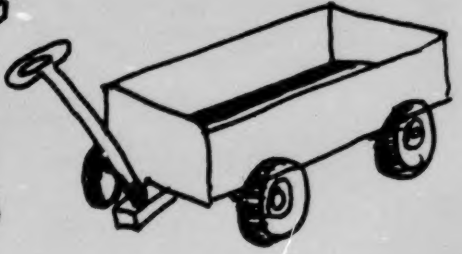


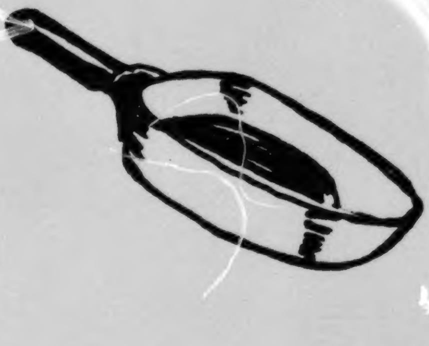


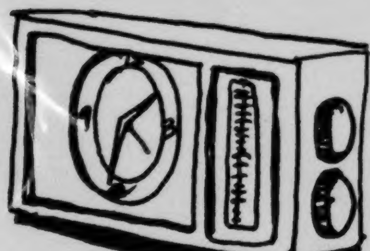


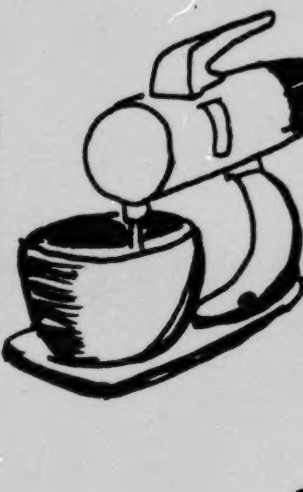




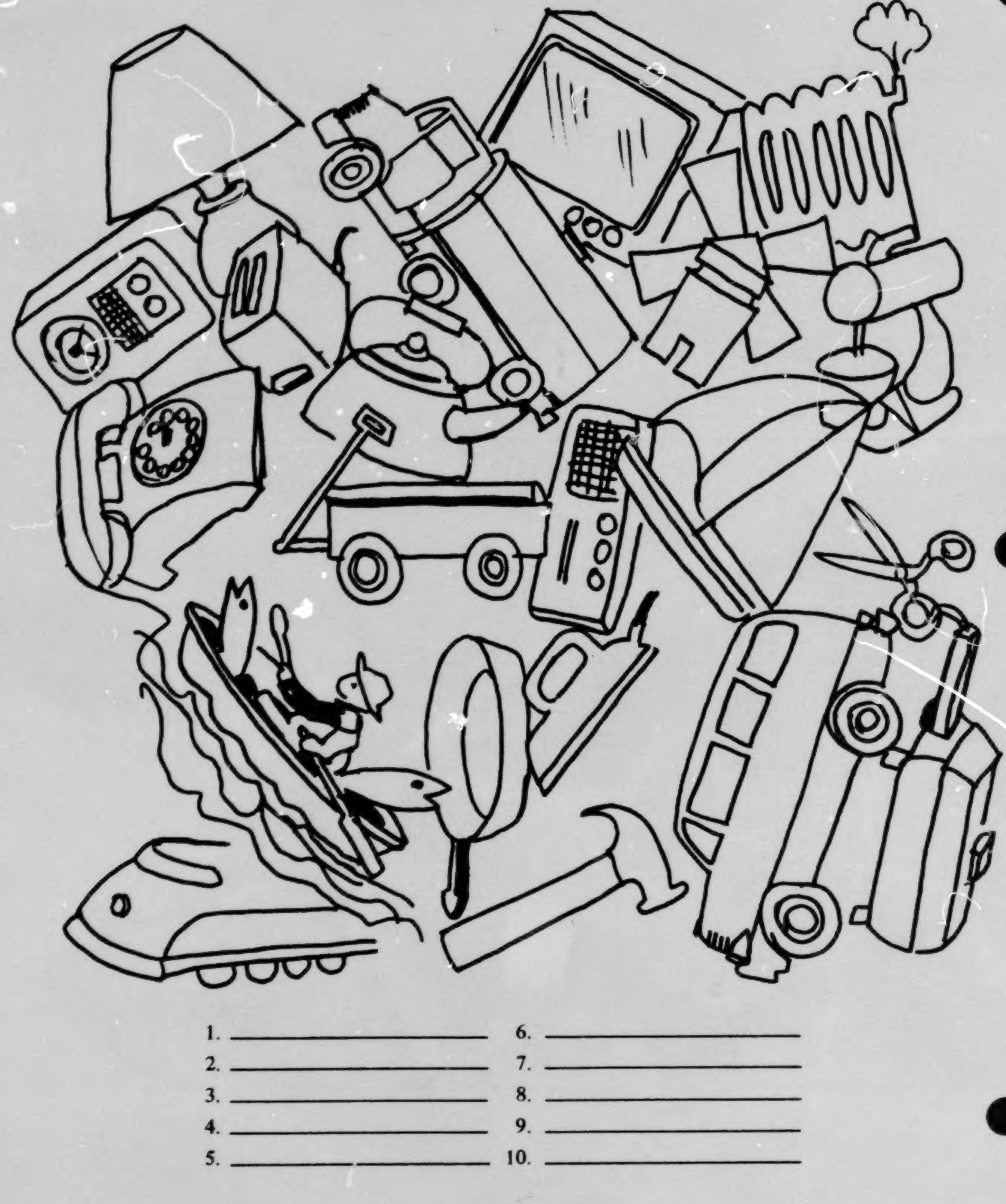




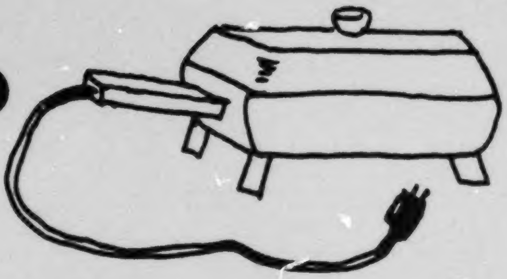
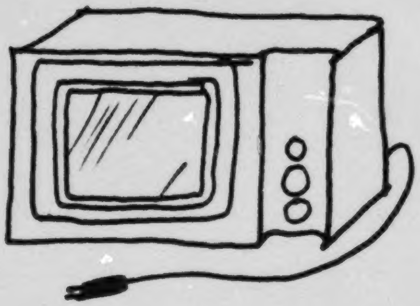
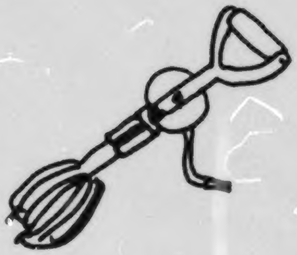
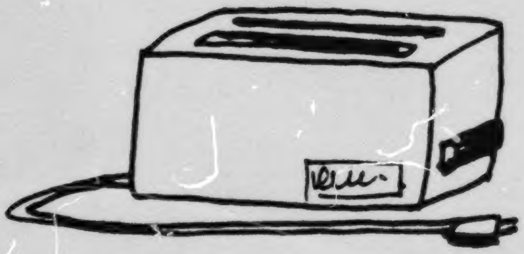
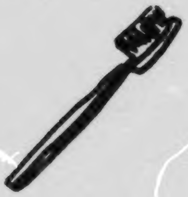
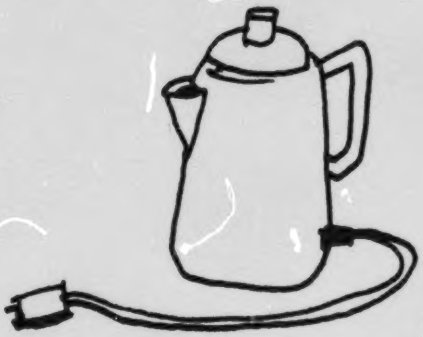
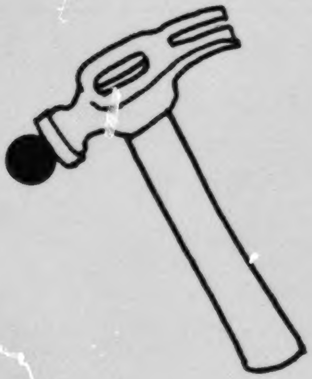
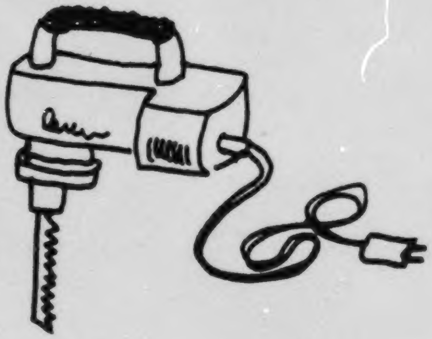
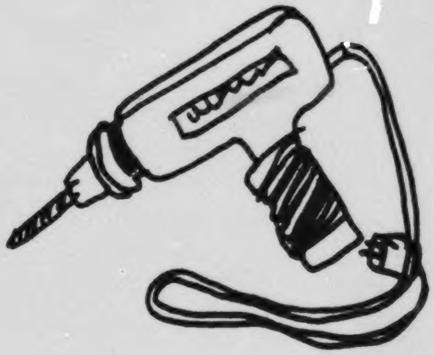
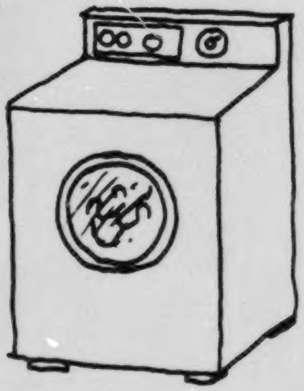
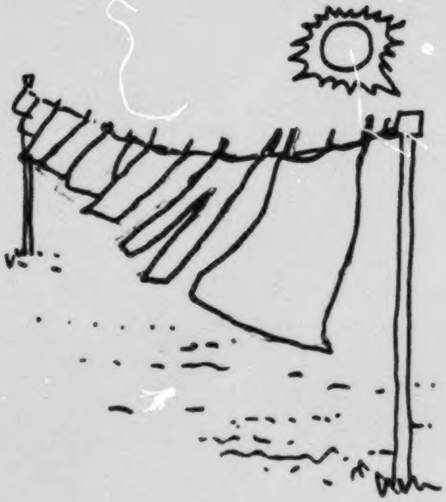
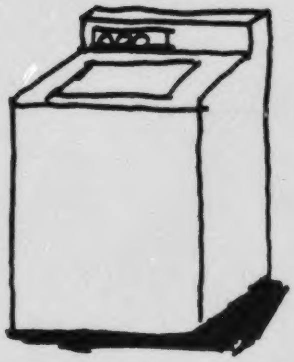




HOW MANY ENERGY USERS CAN YOU FIND?



1. ______________________ 6. ______________________
2. ______________________ 7. ______________________
3. ______________________ 8. ______________________
4. ______________________ 9. ______________________
5. ______________________ 10. ______________________

CIRCLE THE ONE ON EACH LINE THAT DOES NOT USE ELECTRICITY

Grade Level: 1

Disciplines: Art, Language Arts

Objectives:

The student will use energy characters to make cartoon strips about energy, energy sources, and conservation.

Suggested Time: 2 week unit, 15 to 20 minute segments

Materials Needed:

Cutouts of the energy characters that follow, books "Saving Energy*" or "All About Energy", paper, crayons

Teacher Notes:

The subject of energy is a complex one, and the need to conserve energy today for tomorrow's needs is a difficult concept for most Americans to understand. Motivation is needed for people to understand what energy is all about. Children can be influenced by examples of *good* and *bad* characters such as they see on TV or in comic books. In this activity, the understanding of energy is portrayed through an Energy Man (robot). The motivating character for conserving energy is portrayed by a *Cool Cat* and the energy waster by an *Evil Hog*. Teachers may use their imaginations to create other characters.

Teaching Suggestions:

Cut out, color, and mount the cartoon characters. Ask the students to describe them, to tell who the characters are and what they do. Make up a story to introduce the characters to the children. Explain that they will be using the characters to learn more about energy, and will make cartoon strips and stories about them.

Read Sam Epstein's book *Saving Energy* or Richard Dalton's book *All About Energy*. Have the children tell some stories using the cartoon characters. Have them explain what energy is, using the character, Energy Man.

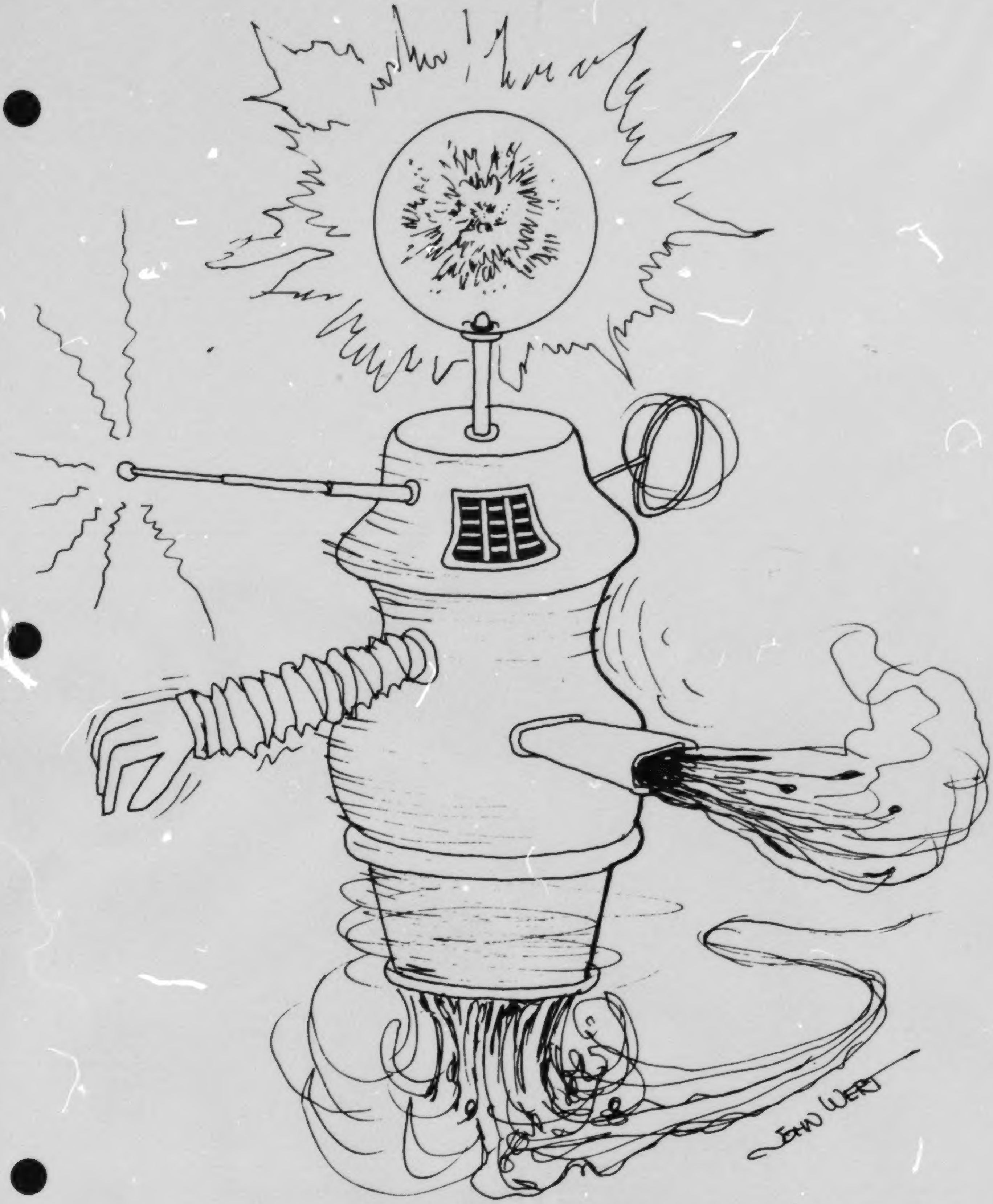
Have the children draw cartoon strips using energy characters. The cartoons which they create can then be shown on a zoetrope (a round cardboard core with slits, mounted on a hand-turned turntable). They can also be shown on a home-made TV screen, using a tape-recorded story made by the children.

Do not color the Energy Man; instead, have the students describe how they would color him. See if you can motivate them to use colors which would identify heat, light, and motion.

Make puppets from the energy characters and put on a puppet show which the students make up about the characters.

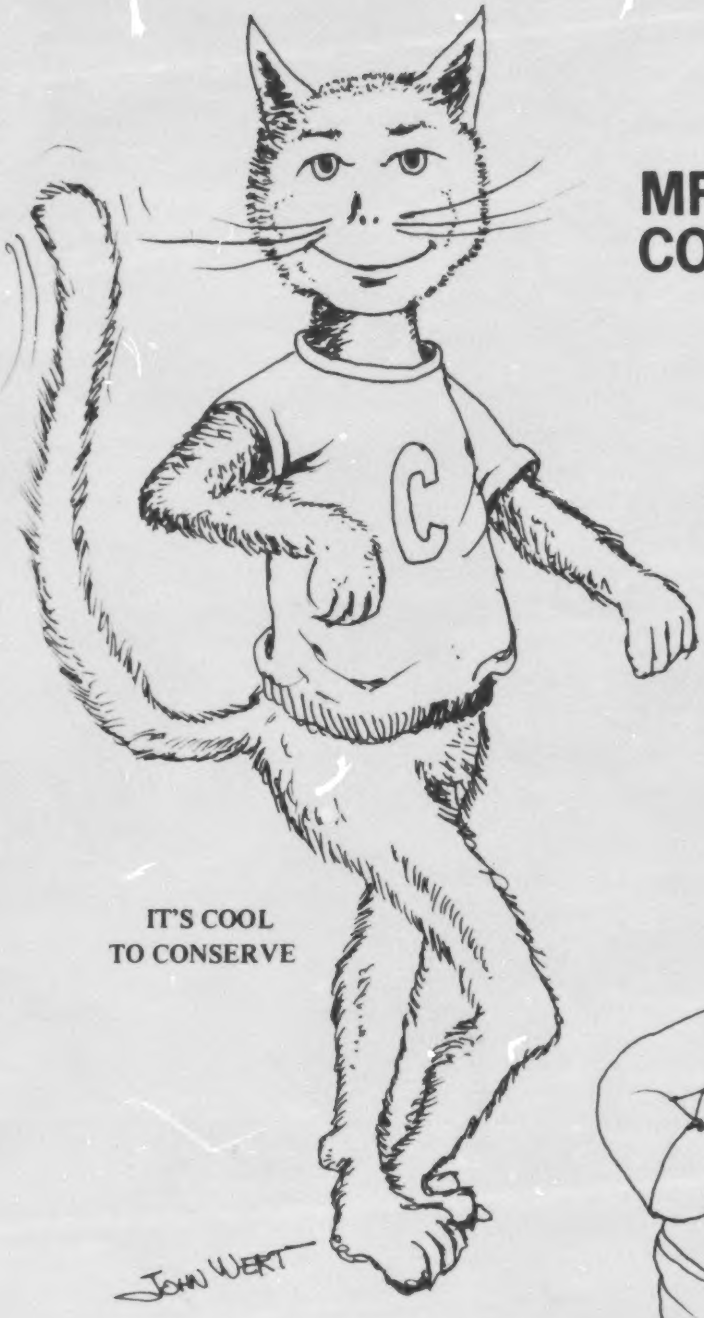
*Saving Energy, Epstein, Sam and Beryl, Gerrard
All About Energy, Dalton, Richard and Kaas, Warren

Adapted from a module by
Joyce Roberts, Brighton
Township School, Beaver, Pa.

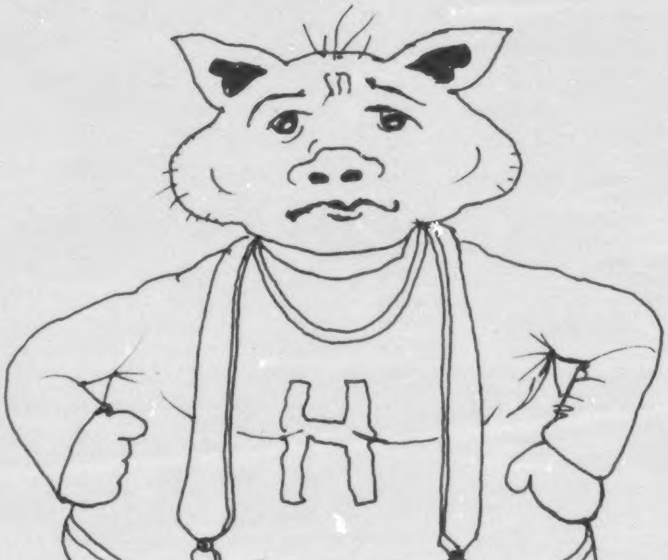


ENERGY MAN

MR. COOL CONSERVATION CAT



IT'S COOL
TO CONSERVE



MR. EVIL ENERGY HOG

Grade Level: 4-6

Discipline: Language Arts

Objective:

Students will complete an energy crossword puzzle.

Suggested Time: One class period

Materials Needed:

Crossword puzzle, *Energy: The Sustaining Force of Life.*

Teaching Suggestions:

Have students complete the puzzle that follows

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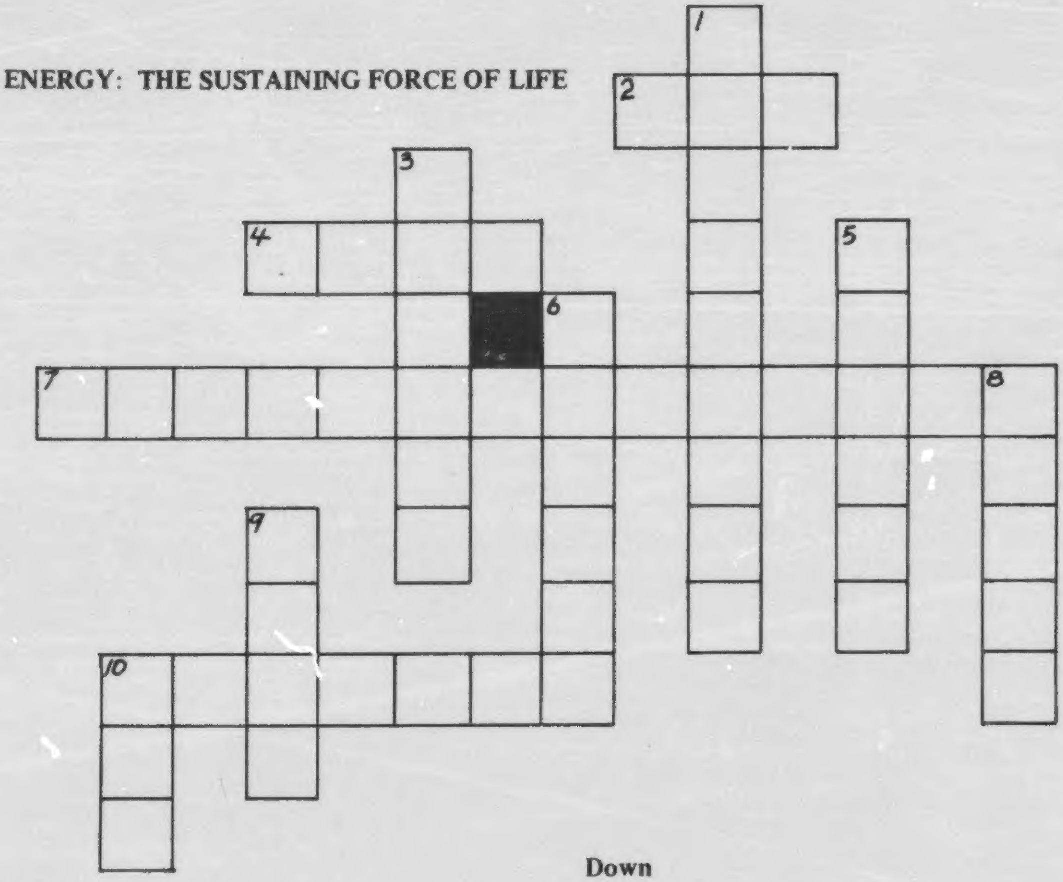
ENERGY: THE SUSTAINING FORCE OF LIFE



CLUES

Across

2. ______is a fossil fuel that is obtained from the earth and used to heat our homes and run our cars.

4. _____was a source of heat for our great-grandparents.

7. The process by which plants change the sun's energy into food is called ________________.

10. _____is the force that draws all objects toward the center of the earth.

Down

1. The ________, which includes the earth's crust and surrounding air, supports all plant and animal life.

3. Energy sources made of plant and animal remains that were buried millions of years ago are called ________ fuels.

5. Scientists are exploring the uses of nuclear _____ as an energy source.

6. ______is the capacity to do work.

8. _____energy is the source of all life on earth. We can use this energy to heat our water and our homes.

9. An abundant supply of ________ is found in Pennsylvania and West Virginia.

10. Natural __________is a clean fuel used in homes and factories, and is becoming more expensive and hard to find.

Grade Level: 4-6

Discipline: Social Studies

Objective:

The students will discuss the finite energy sources of the planet earth.

Suggested Time: 30 minutes

Materials Needed:

Rope, supply of small rocks, spoons, string for boundaries

Two Energy Games

Energy Units

Pick a sandy spot or an area where the grass is sparce and short, and lay down a rope to form a circle about 20 feet in diameter. Scatter about three small handfuls of black beans inside the circle. Ask every other player to step inside the circle. Then ask each inside player to pick up one bean, call it one energy unit, and throw it away. Do this three times.

Say that life has been good, and the population has increased. Ask half of the remaining players to step inside the circle. Have students inside the circle continue to pick up and throw away energy units. Then ask the remaining players to step inside the circle. Have all students continue to pick up and discard energy units until they are very scarce or completely used up.

Discuss the behavior of the players. Did some begin to pick up more than one bean at a time and hoard the resources? Did they hide some beans?

Now using short pieces of rope, divide the circle into *continents* of different sizes. Scatter beans unequally so that one of the smallest areas has the largest number; some of the larger areas, scant numbers; and some big deposits lie close to the boundary rope. Repeat the above game, confining students to their own *continents.* All sorts of parallels to the distribution of energy resources can be noted in this game. Do some players move the boundary rope slightly to get at the beans on the other side? Do some players crowd out others? What happens when players of one continent completely exhaust their supply of beans? Do others voluntarily share? Discuss the behavior of the player, and the parallels with energy resources in the world today.

The Green Machine (A relay game)

Divide the class into groups of three. One person in each group is the sun, one is a clover, and one is a rabbit. The leader is the *Green Machine.* The sun people must carry, one at a time on a spoon, sunbeams (rocks) to the clovers. As soon as a clover has 5 sunbeams, it can trade them for a leaf at the *Green Machine.* (Leaves may be real or imaginary.) They carry the leaf to the rabbit, and this gives the rabbit enough energy to make one rabbit hop toward the finish line. The first rabbit to the finish line wins.

III.
The Definition of Energy

Grade Level: 4-6

Disciplines: **Social Studies, Language Arts**

Objectives:

The student will examine a series of transparencies or pictures illustrating the effects of energy. From this examination, the student will develop a definition of energy. The student will be able to identify several ways that energy was used in the past and in the present. The student will be able to identify several examples of the effects of energy in his/her immediate environment.

Suggested Time: One or two class periods

Materials Needed:

Overhead projector, illustrations that follow or similar pictures

Teacher Notes:

In order to understand the "everywhere" of energy, students need to sense how it affects the daily life of every person. Throughout history, people have developed sources of energy to work for them. Early humans had only the strength of their bodies, primitive tools, and tamed animals to work for them. They used the energy of wind to move sailing vessels, and the energy of water to turn mills. Later, with the invention of the steam engine, steam could be used to run machines. The discovery of electricity created another important way of using energy. So did the invention of the gasoline engine. A new era in the use of energy was entered with the application of nuclear and solar energy.

It is important to differentiate between energy and the effects of energy. Many types of energy cannot be seen; only the effects of the energy (motion and change) can be observed. For example, electrical energy cannot be seen; only the work created by that energy can be observed.

Teaching Suggestions:

The illustrations at the end of this activity show the following:

1. early caveman
2. early colonial miller
3. early sailor
4. Indian starting a fire by using the friction heat from a turning stick
5. Conestoga wagon and team
6. railroad steam engine
7. xylophone player
8. nuclear submarine
9. Franklin's kit experiment
10. early colonial blacksmith
11. potato farmer
12. automobile driver
13. boy drinking water
14. camera taking pictures
15. man hunting animals

Use an overhead projector to show these or other appropriate pictures to the class. Ask the following discussion questions:

What is happening in each picture? (movement or change)
What is moving or changing?
What is causing these things to happen? (water, fire, muscles, steam, etc.)
What do you think it is that is causing all the movement and change? (energy)
What is each movement and change called? (work)

Try now to make your own definiton of energy. (Have students, in pairs or singly, construct written definitions of energy. Share these together.)

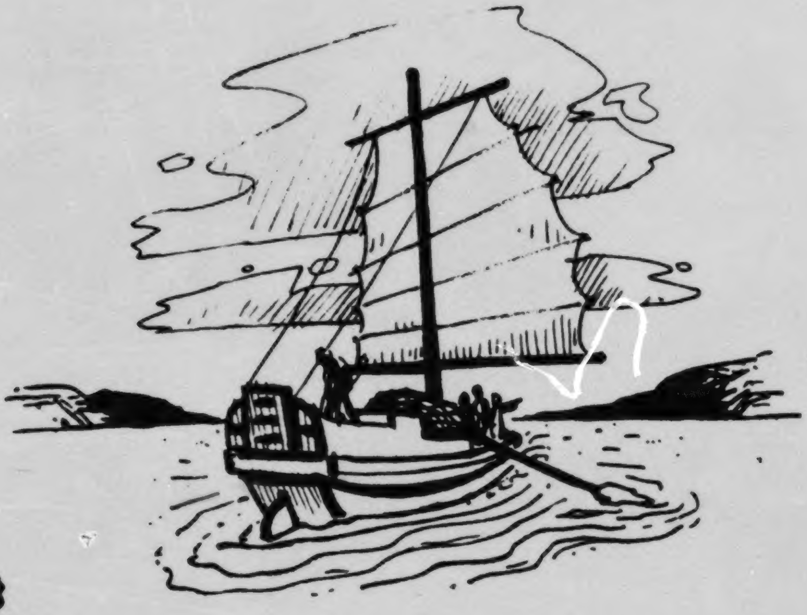
After this, students will probably have to be given the scientific definition of energy and work. Energy is the ability to do work. Work is the movement of matter from one point to another. Ask these additional discussion questions:

Can you think of any other things, in addition to the pictures already shown, that contain energy?
How can you tell? (They make something move or change.)
Can you think of anything that does not contain energy?
(Discuss. List those on which there is some disagreement and keep for future lessons.)

Additional Activities:

Have small groups construct posters or booklets or murals which illustrate energy via drawings and pictures.

Have each student, or pairs of students, demonstrate what energy is using present-day ideas and activities. Encourage students to use their imaginations in working up their demonstrations.



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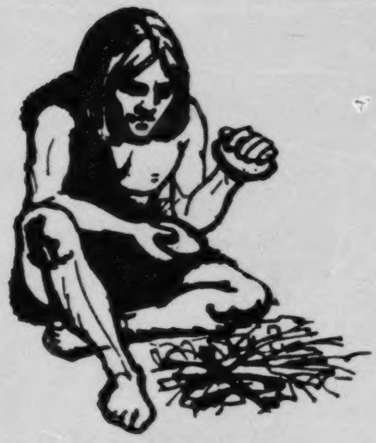

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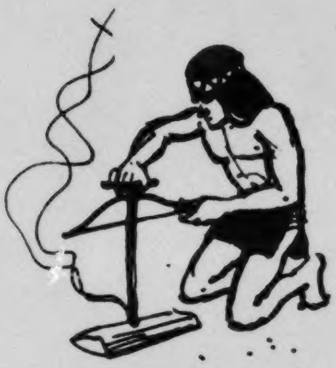

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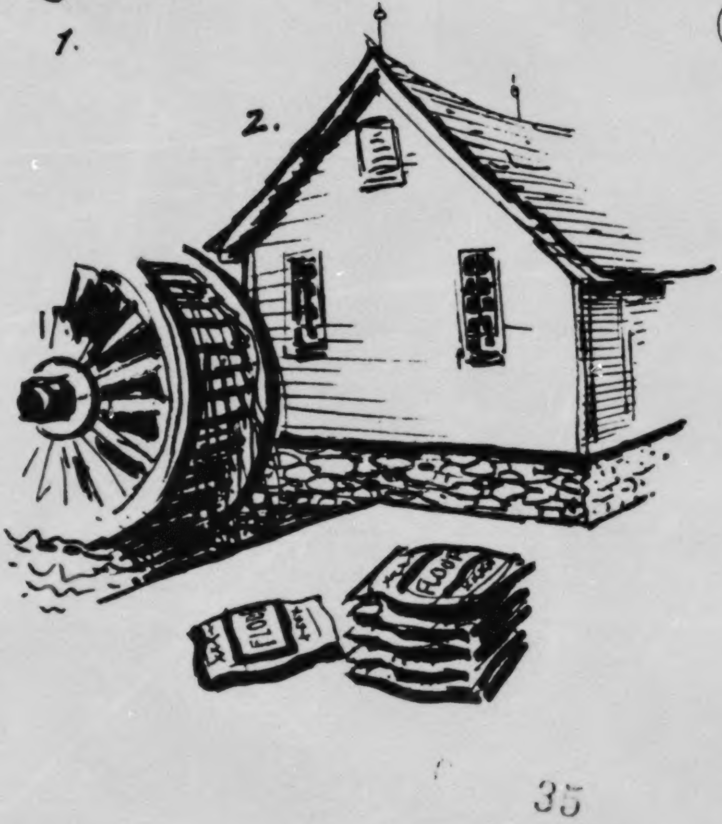
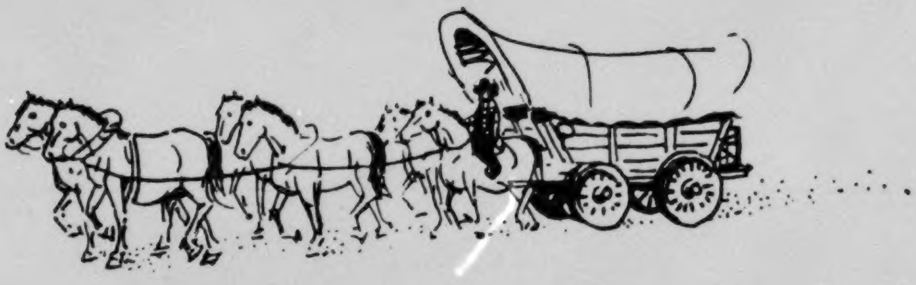


FLOUR
FLOUR



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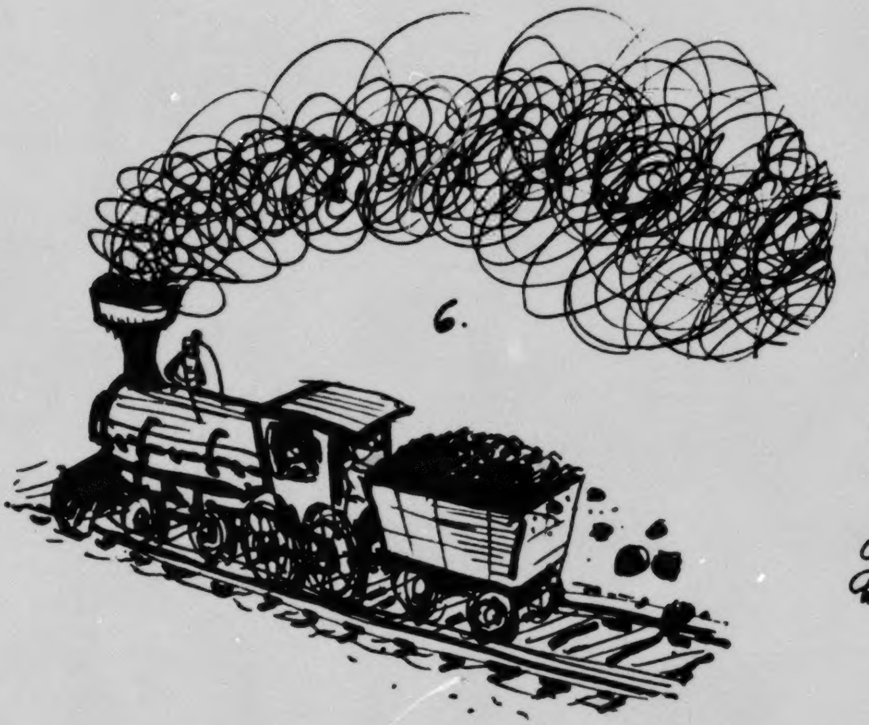

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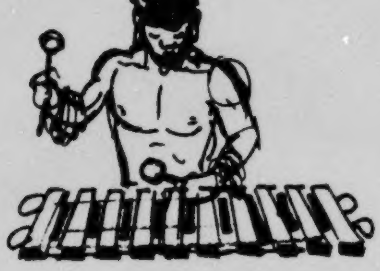

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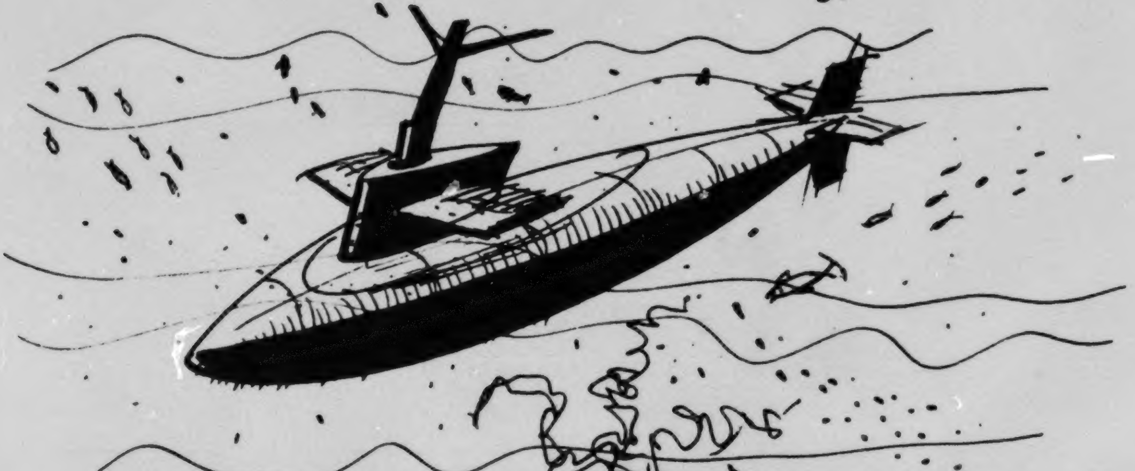

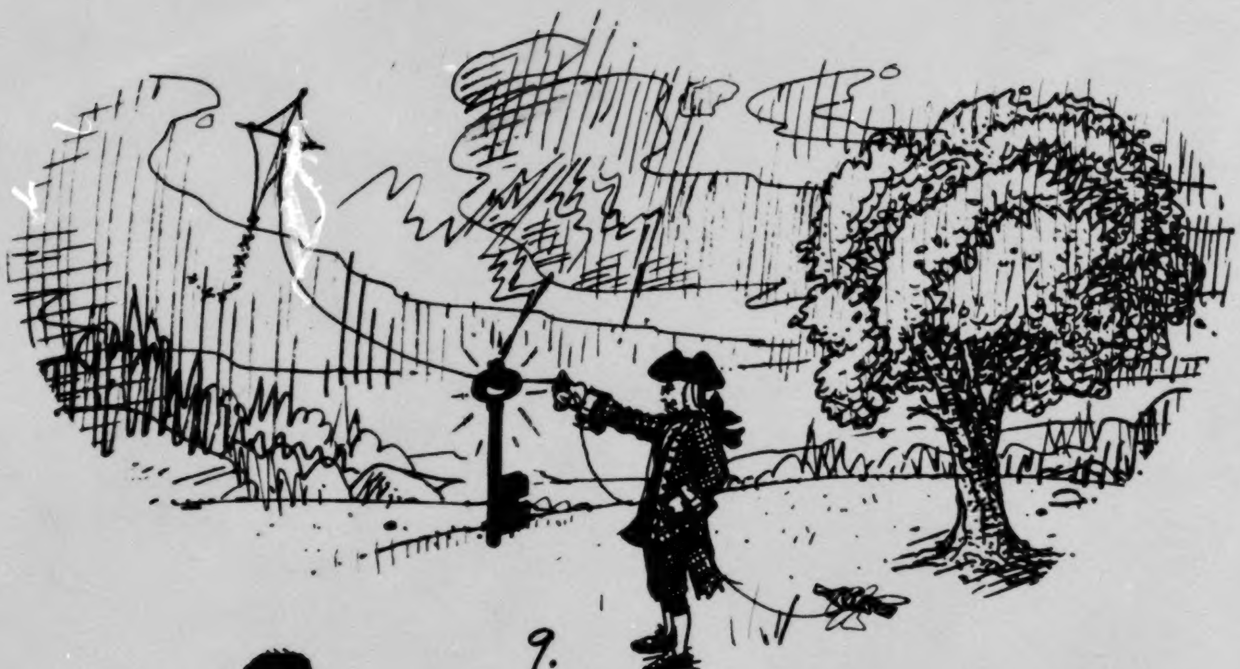

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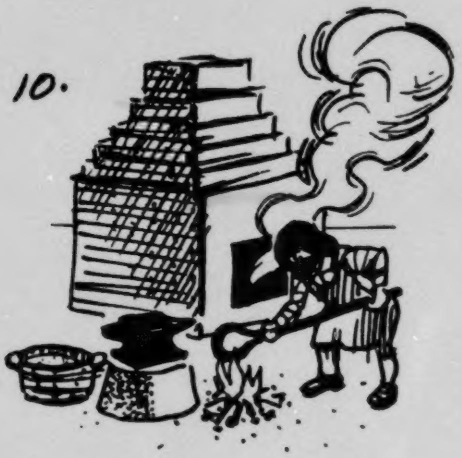

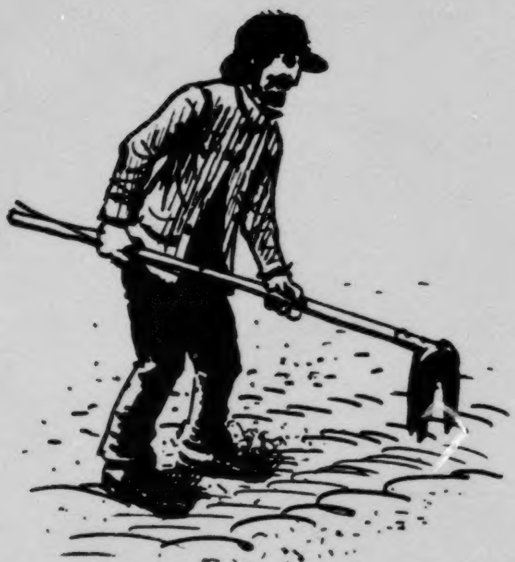

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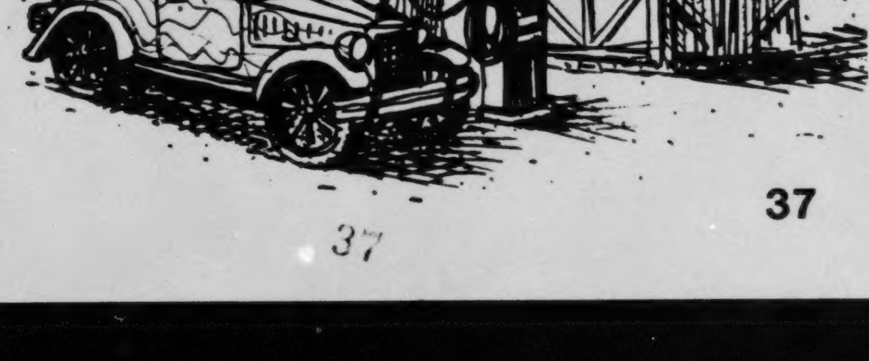

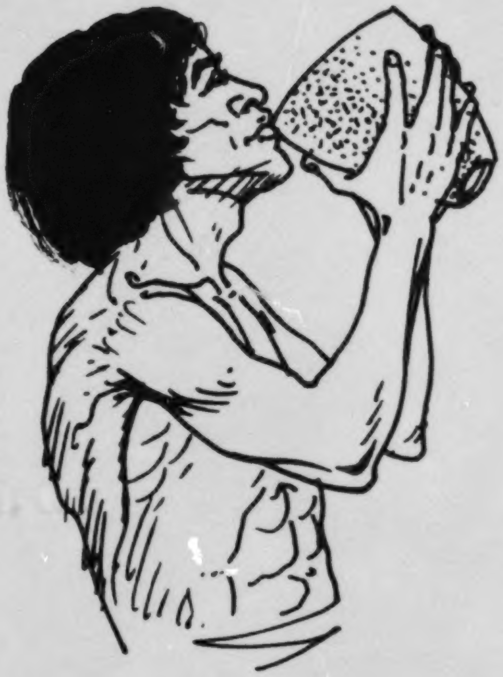

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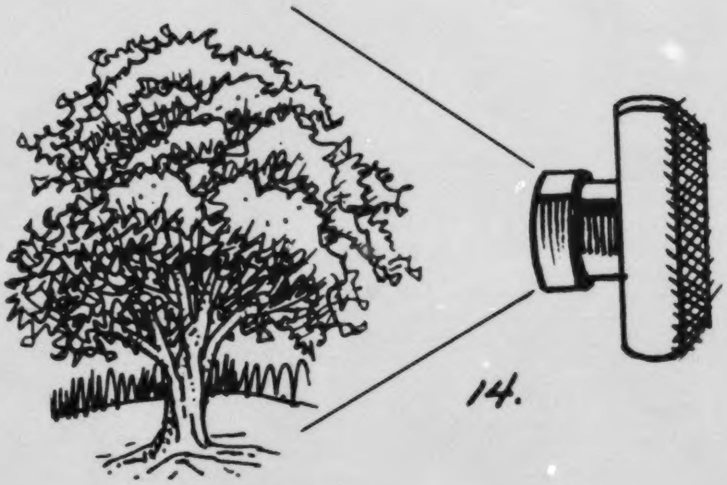

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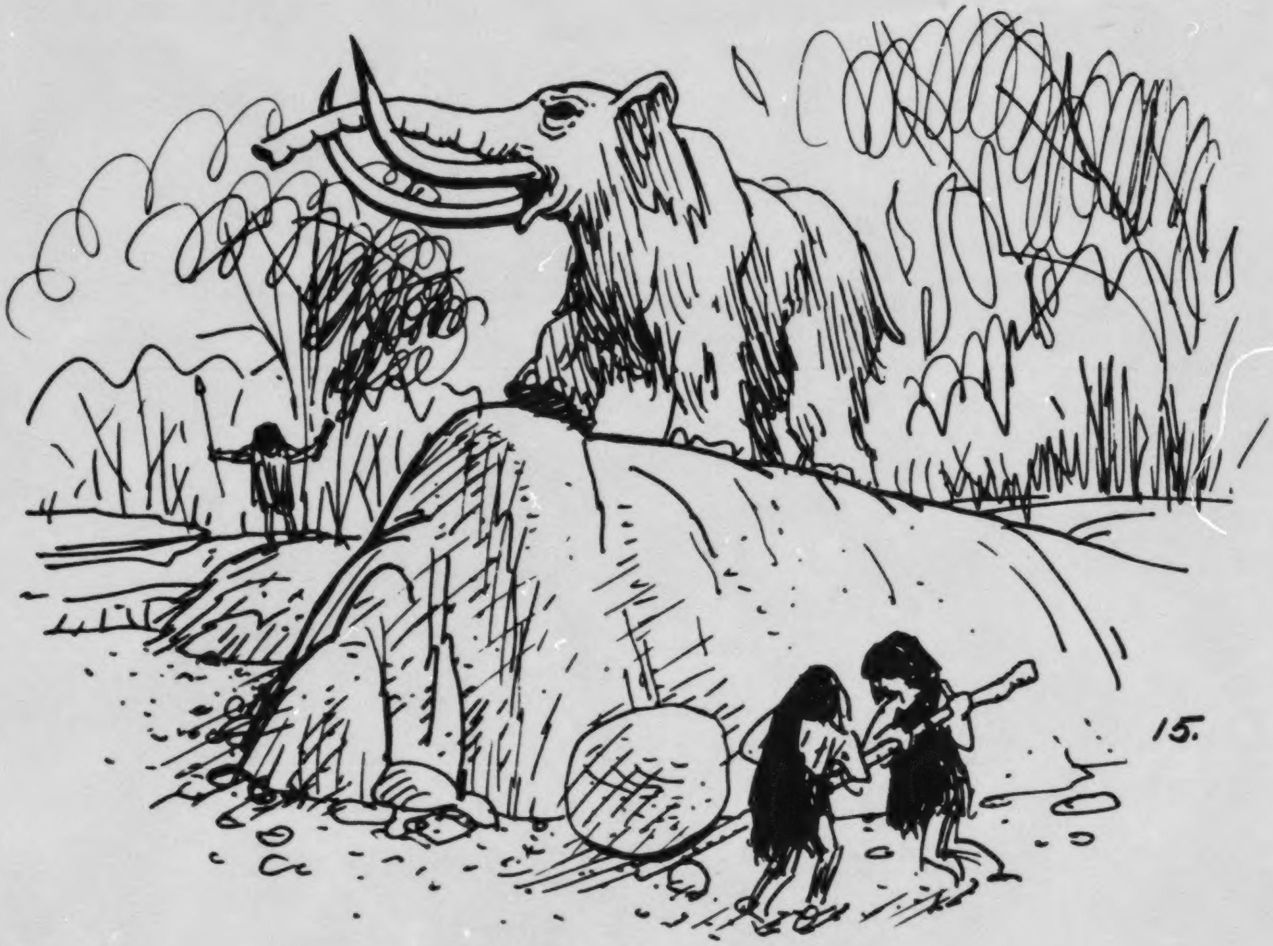


15.

Grade Level: 1-3, 4-6

Disciplines: Science, Language Arts, Social Studies

Objectives:

The student will be able to identify examples of work. The student will be able to classify work as useful, wasteful, or harmful.

Suggested Time: 20 minutes

Materials Needed:

Rope

Teacher Notes:

Scientists define work as a push or pull (a force) that causes an object or substance to move or change in some way. Many kinds of work are done in the world without people being involved. Examples: plants growing, sun drying clothes, wateraalls moving rocks. But people also work, and make machines to work for them. Some of the work people do is useful, some is wasteful, and some is harmful. Examples: useful–construction; wasteful–leaving lights on when not in use; harmful–exploding bombs.

Teaching Suggestions:

Have two students pull tightly on opposite ends of a rope while remaining perfectly still. Ask: Is any work being done? If one student pulls the other over, has any work been done?

Have students visit the playground and make a list of the different ways in which play is actually work in the scientific sense.

Have students make a list of examples of work, and then classify into the categories useful, wasteful, or harmful. Do some types of work fit more than one category? Are other categories needed?

Additional Activities:

Have each student pantomime a type of work while the other students try to guess what type of work it is. Have someone tell how they know work was actually done.

Play a game by having a student give a verb indicating some type of work. Have the others in the class make a complete sentence using the verb. The verbs can be written on cards which the students pick.

Adapted from **Energy: A Teacher's Introduction to Energy and Energy Conservation**, Ohio Department of Education, Columbus, OH

Grade Level: 1-3, 4-6

Discipline: Science

Objectives:

The student will construct a miniature power plant, and will identify the source of its energy and the work done.

Suggested Time: One class period

Materials Needed:

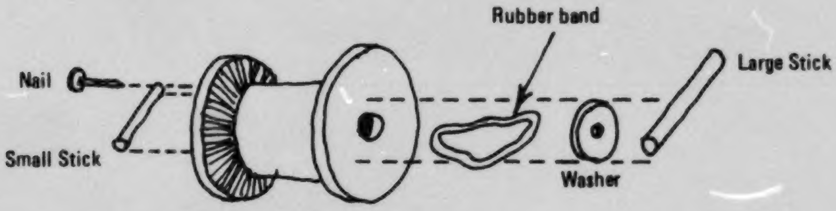
Rubber band, empty wooden spool, two wooden matches or two pieces of plastic straw, one slightly shorter than the diameter of the spool and one slightly longer, a 1/4 inch thick wax washer cut from a pieces of candle, and a small nail

Teacher Notes:

Energy is so basic that nothing moves or is accomplished without it.

Teaching Suggestions:

Drive the nail into one end of the spool, about 1/8 inch from the hole. Cut a 1/4 inch thick slab of wax from the end of a candle. Make a hole in the center where the wick was. Thread the rubber band through the hole in the wax washer and the hole in the spool; loop it over the large stick at the end with the wax washer and over the small stick at the end with the nail. Wind the large stick about 10 to 20 turns, place the spool on a flat surface, and release it. The spool should move forward at a slow, even rate.



Discussions concerning energy and work can be generated while working with these power plants. Discussion questions:

Why does the spool move? What is its source of energy? What was the work performed by the plant? How could we get the plant to perform more work? Can you think of any way that we might produce a similar but longer power plant? If the power plant did not move, would any work have been produced?
If the power plant did not move, would there still have been energy present?)Answer in a subsequent lesson on potential and kinetic energy.)

Adapted from **Our World of Energy**, Philadelphia Electric Company, 1977.

Grade Level: 4-6

Disciplines: Science and Math

Objectives:

The student will be able to compute the amount of work performed in an experiment, define work as being force times distance, and label work in the proper units.

Suggested Time: One class period for each activity

Materials Needed:

Stack of about 10 books per student; ruler or yardstick, bathroom scales, stairs, copies of tables to record information

Teacher Notes:

Work, the movement of an object from one point to another, is measured by multiplying force times distance. The farther an object is moved and/or the greater the force used, the greater is the amount of work done. A common system measures force in pounds and distance in feet; thus the unit of work in that system is the foot-pound.

Teaching Suggestions:

Activity 1

Have each student weigh out five pounds of books. Have each student measure the distance from his/her desk top to the floor, making the measurement in feet. Then have the students place the five pounds of books in a stack on the floor beside his/her desk. Have each student lift the stack of books and place on the desk top. Record this information on a table. Repeat the above procedures with a 10 pound stack of books.

MEASURING WORK PRODUCED IN LIFTING BOOKS

FORCE	X	DISTANCE	=	WORK
(WEIGHT OF BOOKS)	X	(DESK TOP ABOVE FLOOR)		(FOOT-POUNDS)
5 lbs.				
10 lbs.				

Questions:

The heavier the stack of books, the ______________(more less) work was done.
The heavier the stack of books, the ______________(more, less) energy was used.
Where did the energy come from that was used to lift the stack of books?
Can you think of ways that huge boxes of books could be lifted that would be too heavy for us to lift?
How did you determine the work you performed in the experiment?

Which creates more work: 5 books moved 50 feet or 100 books moved 2 feet? Assume that each book is the same weight.
Can you illustrate a situation in which more force would create less work? Less force would create more work?
Can you think of a way which has been found so that you need less energy to pedal a bicycle? Would this change the work?

Activity 2

Have each student determine his weight (gravitational pull). Find a convenient stairway and have three or four students determine the amount of rise in each step and the number of steps. Record this information on the chalkboard. By multiplying the amount of rise in each step by the number of steps, determine the amount of total rise in the stairway. Have each student record this on his/her table.

Have each student walk up the stairway once. Have each student determine the amount of work he/she did in walking up the stairway. The student should multiply force (weight) times distance (total rise of stairway). Record this on the table. Each student might record information about four or five more students for the purposes of comparison.

MEASURING WORK ON A STAIRWAY

FORCE IN POUNDS	X	DISTANCE IN FEET	=	WORK (FOOT-POUNDS)
(STUDENT'S WEIGHT)	X	(TOTAL RISE OF STAIRWAY)	=	NUMBER OF FOOT-POUNDS)

Questions:

How did you determine the work you performed?
Where do you think the energy came from which enabled you to perform this work?
What was the factor that resulted in different amounts of work for each student?
Suppose you used an elevator or escalator to do the same work that you did by walking up the stairway. Would you use more or less energy when you rode the elevator of escalator? Explain.
If you traveled a longer distance on an elevator or escalator than you did on the stairway, would you have used more energy? Produced more work? Explain.
If you did not use any of your own energy on the elevator or escalator, where did the energy come from to do the work?
Would it take more or less energy to run an elevator or escalator than it took you to walk up the stairway?

Adapted from **Energy for Intermediate Grades**, N.Y. Electric and Gas Corp., Binghamton, NY

IV.

Potential and Kinetic Energy

Grade Level: 4-6

Discipline: Science, Social Studies

Objectives:

The student will explain and demonstrate potential and kinetic energy.

Suggested Time: One class period

Materials Needed:

ball, marble, inclined plane, container of water, empty container, drinking straws, small strips of paper

Teacher Notes:

Two general categories of energy, encompassing all the various forms, are potential energy and kinetic energy.

Energy that is stored is called potential energy. It is energy that an object has because of its position or condition. Many times potential energy represents stored-up energy. For example, a thightly stretched spring has potential energy because it has the ability to do work if released. A rock lying at the top of a hill also has potential energy since it can do work if allowed to roll down the hill. A pile of coal has potential energy, since work can be done when the coal is burned. A rifle that is loaded and ready to fire also has potential energy. The water stored up behind a dam is in a position where the force of gravity will enable the water to fall over the dam when released. While stored up, the water has potential energy. A log by the fireplace has potential energy also. This energy is released as heat when the log is burned.

The energy that an object has because of its motion is called kinetic energy. If a stretched spring is released, it has kinetic energy. When a loaded rifle is fired, heat and expanding gases cause the bullet to have kinetic energy. A rock rolling down a hill, a moving baseball, a skier skiing down a mountainside, a boy running around a track, water flowing over a dam–all these are examples of kinetic energy.

Teaching Suggestions:

Hold a ball in your hand. Ask: What is the ball doing? (resting, or not moving) Toss the ball upward, or toss it to a few students. Ask: What is the ball doing now? (moving)

Give each pair of students a marble. Each pair should also have available a book or notebook. Have one student of each pair lift up the edge of the book to make an inclined plane, and have the other student hold the marble at the top of the inclined plane. Ask: What is the marble doing at the top of the inclined plane? (resting, not moving). Have the students release the marbles, allowing them to roll down the inclined planes. Ask: What did the marble do? Can you tell the two different kinds of energy we saw in these activities with the ball and the marble? (Resting energy and moving energy) Tell the students that scientists call resting energy potential energy; many times potential energy is stored-up energy. The moving energy is called kinetic energy.

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Hold up a container of water. Ask: What is it doing? (resting) What kind of energy does it have as I hold it up? (Potential) How could I turn this potential energy into kinetic energy? (Pour the water out) Pour the water into another container. Ask: Was the water moving? What kind of energy does moving water have? (Kinetic)

Ask: In the first two experiments we used solids; in the second we used a liquid. Can you think of any way we might illustrate potential and kinetic energy with air? (Get suggestions)

Give each child a straw and a strip of paper a few inches long. Have them hold the paper still in the air. Ask: What surrounds the paper? (Air) Is the paper moving? Why not? (Air is resting or not moving.) How could we move the paper with air only? (Blow through the straw) What kind of energy did the moving air have? (Kinetic)

To compare potential and kinetic energy, discuss such questions as follows: When does a car have potential energy and kinetic energy? Bicycle? Football? Electric fan? Dam? Bullet? Fuel oil? Rubber band? Piano? Pencil?

Additional Activities:

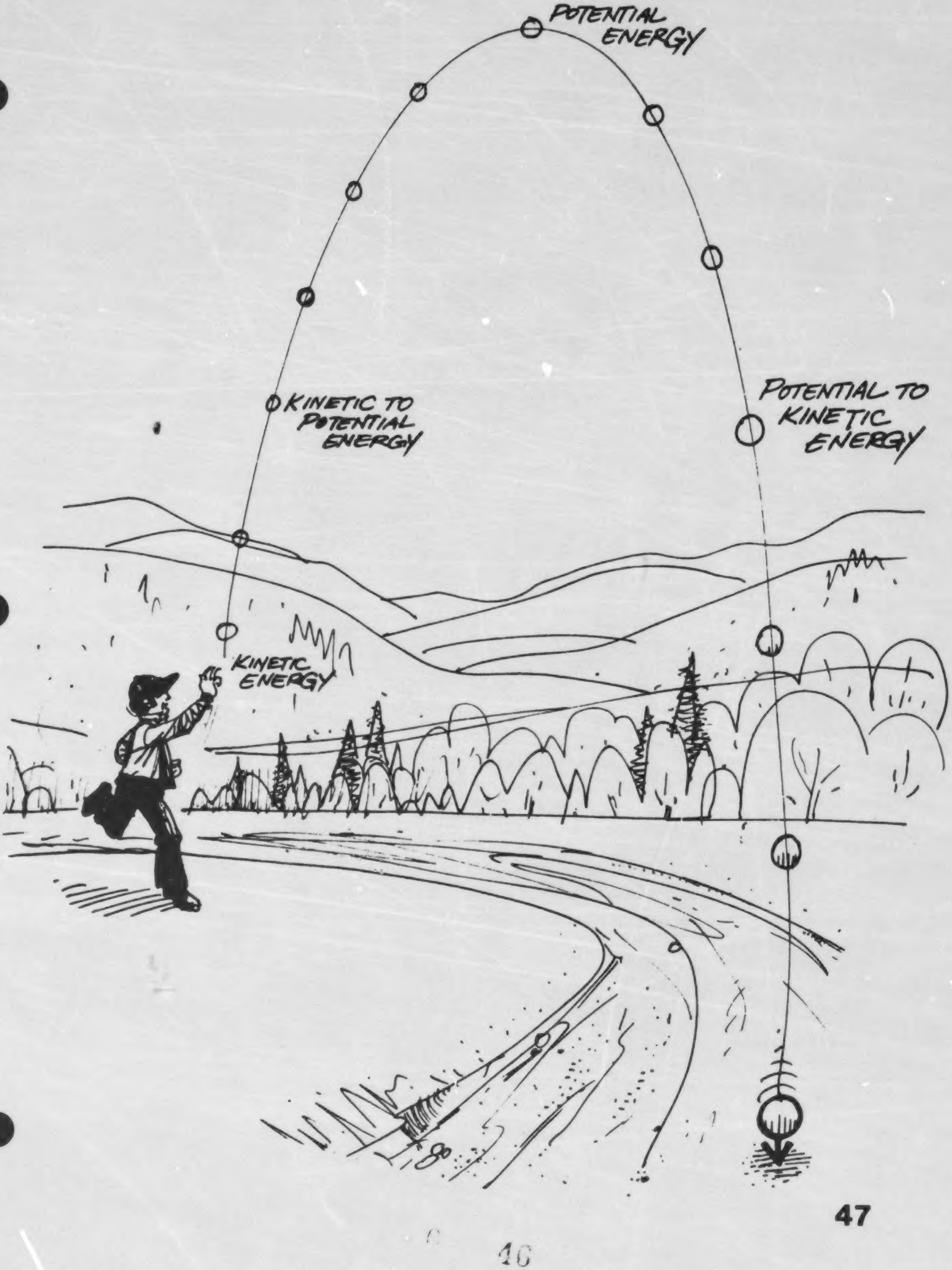
Have pairs of students demonstrate potential and kinetic energy with the following objects: football, hockey puck, soccer ball, electric fan, toy vehicle, rubber band, chalk, battery and bulb, pendulum, playground swing, sliding board, bicycle, windup toy. Discuss or identify work accomplished.

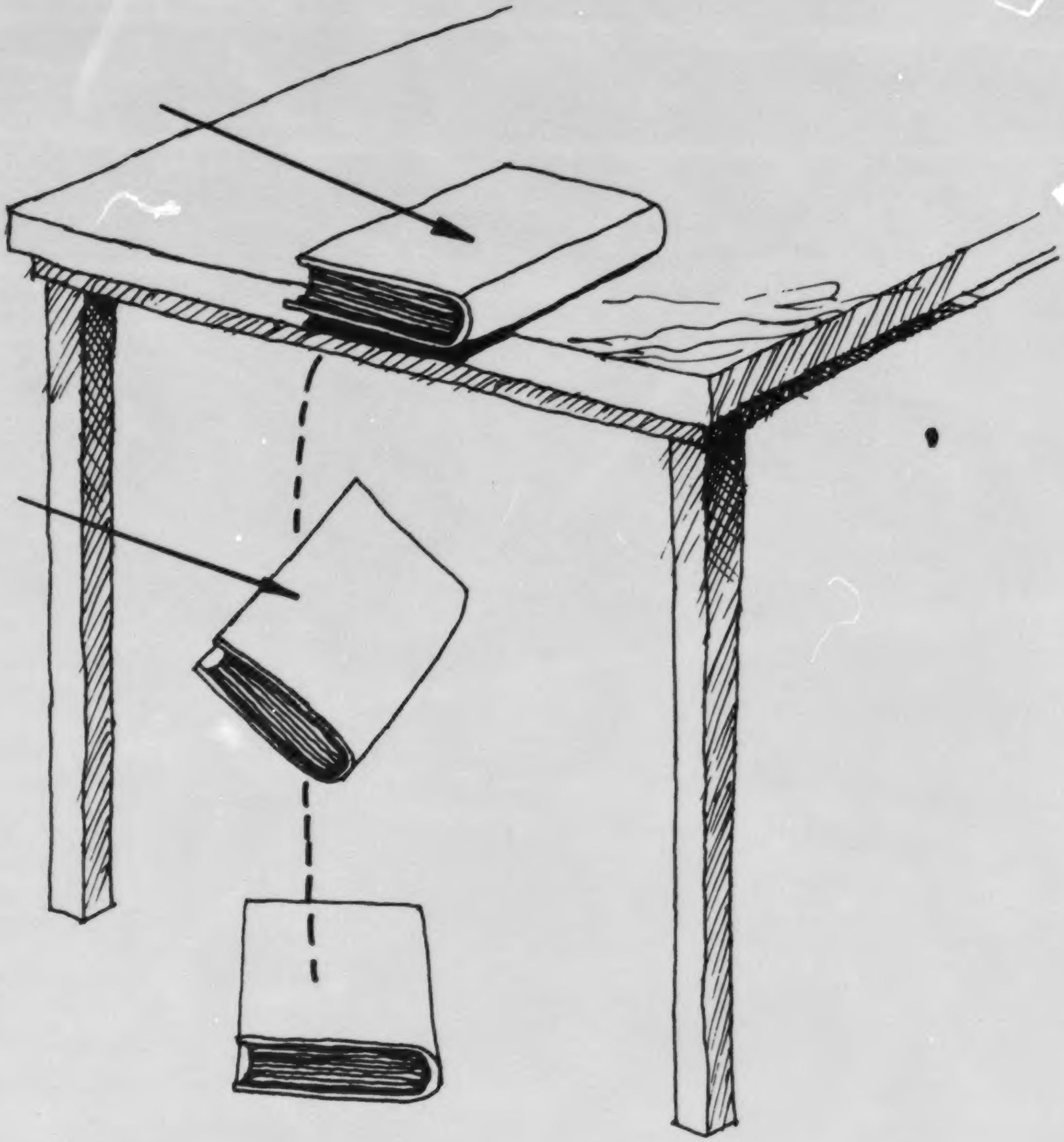
Construct a simple dam and demonstrate potential and kinetic energy.

Name many types of sports and identify examples of potential and kinetic energy associated with each. Examples: skier poised at top of slope, tennis player preparing to serve, football team waiting for signal of quarterback, track star waiting for gun signal, swimmer positioned to start race. Cut out pictures from sports magazines illustrating both potential and kinetic energy and use to construct posters or bulletin boards.

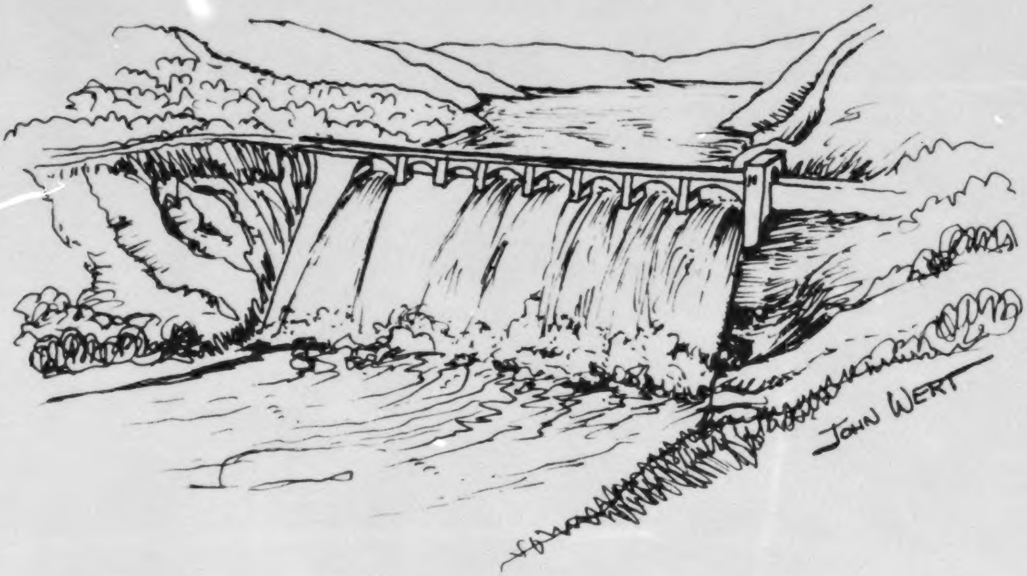
Adapt the activities on pages 36-38 of the **Pennsylvania Energy Curriculum for the Middle Grades.***

*Available from Pennsylvania Department of Education, 333 Market Street, Harrisburg, PA 17126

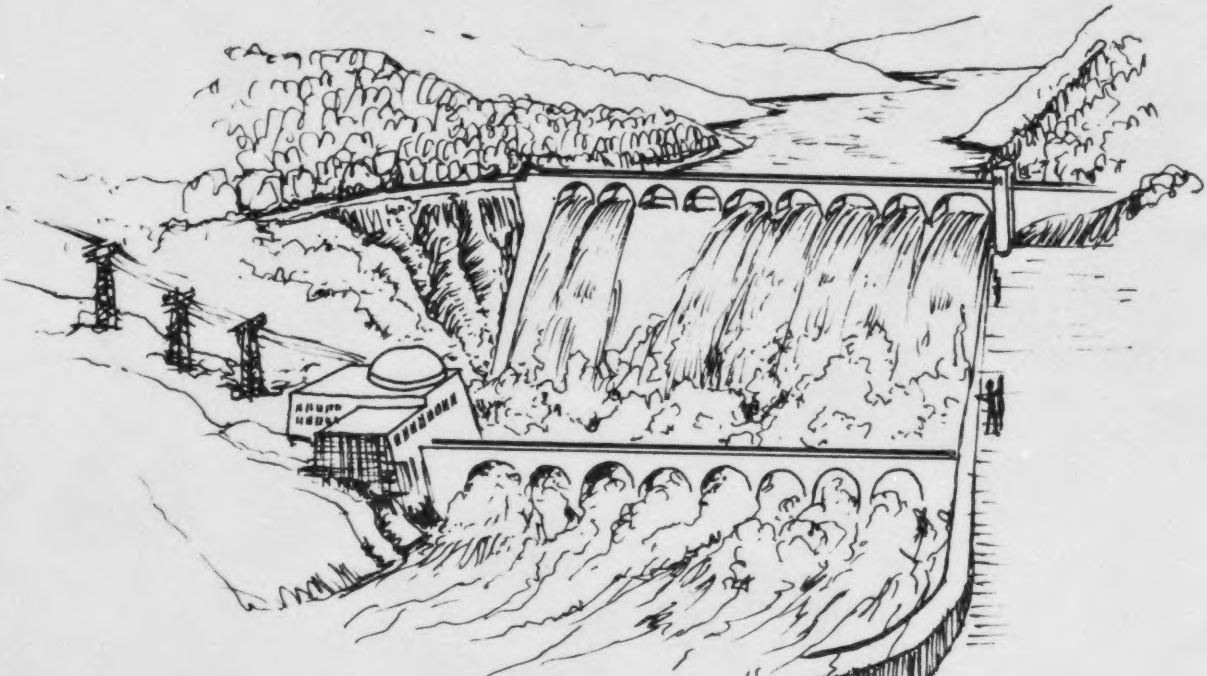

POTENTIAL ENERGY
KINETIC TO POTENTIAL ENERGY
POTENTIAL TO KINETIC ENERGY
KINETIC ENERGY



A dam put across a river makes the water stop. The water builds up behind the dam and makes a lake, and even though the lake looks like it is doing nothing, it is really storing energy. This stored energy is called potential energy.



When stored water is allowed to fall over the dam, its energy is set free. The energy of moving water is called kinetic energy.



Energy of motion, kinetic energy, is strong enough to turn large machines that make electricity.

V.

Forms of Energy and Energy Conversion

Grade Level: 2

Discipline: Science, Social Studies

Objectives:

The student will recognize that a burning fuel gives off heat and light energy.

Suggested Time: 20 minutes

Materials Needed:

Candle in holder, kerosene or oil lamp with fuel, picture of campfire

Teacher Notes:

Long ago, before there were electric lights, kerosene lamps were used to light homes at night. Even today, there are many places where they are used. When we burn a candle, a piece of wood, or other fuel, energy that has been stored in the fuel changes to other kinds of energy, such as heat and light. We can feel the heat and see the light when a fuel burns.

Teaching Suggestions:

Show the class a picture of a campfire. Ask: Where is the light coming from? Will it stay this light all night long? Why not? Through discussion, help the students make assumptions such as: Light is coming from the campfire. When the wood is completely burned, there will be no more fire, heat, or light. More wood must be added to the campfire to keep the fire burning all night long in order to have heat and light.

Show a lamp and its fuel, and light it for the class. Explain that the wick is soaked with fuel which burns in the lamp. Ask questions similar to the ones about the campfire so that the children can make these assumptions: Light comes from a fuel that burns in the lamp. If there is no fuel in the lamp, there would be no light from it. Once the fuel is used up, the lamp will go out.

Place a candle in a sturdy holder on a fireproof surface. Darken the room and light the candle. Let the children come forward to feel the heat. Use the demonstration to show that heat as well as light results from the burning of a fuel.

Ask: What was causing light in all three examples? What will make the light go out in these cases?

Adapted from a module prepared by Cindy Rossi

Grade Level: 3-6

Discipline: Science

Objective:

The student will identify examples of mechanical energy, and will demonstrate conversion of mechanical energy into another energy form.

Suggested Time: One class period

Materials Needed:

Movable objects around the classroom, quarter inch wood dowel, knife, hand drill, wooden block

Teacher Notes:

Mechanical energy is that form of energy which is acquired or released by moving objects. A rolling wheel, a turning windmill, and a rotating waterwheel are examples of objects with mechanical energy.

Mechanical energy can easily be changed into other useful forms of energy. Falling water can spin the blades of a turbine and the mechanical energy of the spinning turbine can be converted into electrical energy in a generator.

Other forms of energy can be changed into mechanical energy. For example, gasoline (chemical energy) can, under combustion, cause parts of a motor to move.

By its very nature, mechanical energy is closely associated with kinetic energy.

Teacher Suggestions:

There are many examples of turning objects (doorknobs, pencil sharpeners, bicycle wheels, frisbees) and push and pull objects (light switches, doors, windows, pencils) to illustrate the idea of mechanical energy right in the classroom. Allow students to come up with as many ideas as possible. If a set of gears, like from a watch or clock, is available, they would be able to see different speeds being produced by mechanical energy.

To demonstrate the conversion of mechanical energy into another energy form, sharpen a quater-inch dowel to a point. Fasten the blunt end in a hand drill. Cut a small pit in a wooden block for the pointed end of the dowel to fit loosely. Have another student hold the block and turn the crank of the drill rapidly. What form of energy is produced when you turn the crank? After a few minutes feel the end of the dowel and the pit in the wooden block. What form of energy do you feel?

Grade Level: 3-6

Discipline: Science

Objective:

The student will be able to demonstrate heat energy

Suggested Time: One class period

Materials Needed:

Candle, flat plate or dish, a 6 ounce can with both ends removed, 3 checkers (or something similar in size and thickness), a pin-wheel, matches.

Teacher Notes:

Early experiments showed that heat had to be some form of motion. But obviously an object can be hot without any motion being visible. The tiny parts that move are molecules, and the higher the speed of the molecules in an object, the greater the amount of heat energy it contains.

Heat can be thought of as the simplest form of energy, since it is the form of energy into which all other forms can be most readily converted. It is also the form that is most difficult to convert into any other form.

Teaching Suggestions:

Cut the length of the candle to half the height of the can. Set the candle on a flat dish to catch the drippings. Arrange three checkers around the base of the candle in such a way that the can will rest on them, thus allowing for some air to enter at the base of the can. Light the candle and set the can over it on the checker base. Hold a pinwheel (preferably one with metal blades) over the flame and above the can a short distance. The pinwheel should spin due to the heated air rising. This illustrates heat energy being converted into mechanical energy.

Other Suggested Activities:

Heat a tea kettle and put a pinwheel near the spout. Try holding a pinwheel over a hotplate. Heat a flask of water to which a baloon has been attached. Rub hands together briskly and rub desk top briskly with piece of paper; then feel heat generated in the desk top by friction.

Grade Level: 2-6

Discipline: **Social Studies**

Objective:

The student will identify a variety of different sources of heat energy.

Suggested Time: 15 minutes

Materials Needed:

Paper and pencil

Teacher Suggestions:

Have the students list as many different sources of heat as possible and describe what heat does for them. This could be limited to a certain environment, such as the home.

Examples:

Source of Heat	*Benefits*
Stove burner	Cooking food
Immersion heater	Heating liquids
House furnace	Space heating
Hot water heater	Water heating
Electric iron	Pressing clothes

Grade Level: 3-6

Discipline: Science

Objective:

The student will demonstrate that chemical energy can do work.

Suggested Time: One class period

Materials Needed:

Balloon, flask or narrow-mouthed bottle (balloon must fit over mouth of bottle or flask), vinegar, baking soda, water

Teacher Notes:

Chemical energy is that energy which is involved in chemical reactions. In most chemical reactions, energy is usually released or absorbed in the form of heat. Examples of chemical reactions are: photosynthesis, respiration, explosion of gunpowder, rusting of iron, operation of a battery. The burning of fuels such as wood, coal, gas, and oil provides for the release of stored chemical energy. Note that often some initial energy, such as heat energy, is necessary to start these chemical reactions.

Teaching Suggestions:

Put about 2 teaspoons or 10 ml of baking soda in a flask or narrow-mouthed bottle. Add about one inch or 2# cm of water. Put about 1 tablespoon or 15 ml of vinegar into the balloon. Holding the balloon so that the vinegar does not run out, fit the balloon over the mouth of the flask and attach with string or rubber band. After the balloon is secured to the top of the flask, lift up the balloon so that the vinegar runs down into the soda and water mixture. Observe what happens. Feel the temperature of the flask. What happens to the balloon? When vinegar and baking soda combine, a chemical reaction occurs which produces a gas (carbon dioxide). The molecules in a gas move faster than in a liquid, causing heat and expansion.

This same experiment could be done using crumbled Alka-Seltzer in the balloon and plain water in the flask. CAUTION: DO NOT DO THIS EXPERIMENT WITH OTHER CHEMICALS OR HOUSEHOLD LIQUIDS.

Grade Level: 5, 6

Discipline: Science

Objective:

The student will demonstrate the effect of heating an object through radiant heat transfer

Suggested Time: One class period

Materials Needed:

200 watt light bulb, lamp socket with cord, masking tape, 2 thermometers, aluminum foil, black plastic tape

Teacher Notes:

Energy in the form of electromagnetic waves which radiate from their source is often called radiant energy. The sun is the main source of radiant energy. It radiates light and heat energy as well as ultraviolet rays, gamma rays, x-rays, and radio waves. In this experiment, the light bulb gives off radiant heat energy in all directions. This radiant heat energy is absorbed by most objects located in the path of the rays. The further the object is located from the source of energy, the fewer rays will strike a given area of the object's surface. Thus the heating effect is less intense at a greater distance. The aluminum foil tends to reflect radiant heat energy, while the black tape tends to absorb a greater portion of heat energy.

Teaching Suggestions:

With some masking tape, tape a socket cord to a support rod high enough to permit a 200 watt bulb to hang 2 feet above the table. Place your hand 2 inches from the lamp, and turn on the lamp. What is the effect? Hold a tablet or book between your hand and the lamp. What is the effect now? Now place your hand about 4 inches from the lamp. Move your hand farther and farther from the lamp, stopping at various intervals. What effect does distance have on heating by radiant heat energy?

Measure the normal room temperature with a thermometer. Wrap aluminum foil tightly around the bulb of one thermometer and black plastic tape around the bulb of another thermometer. Hold the thermometer bulbs about two inches from the light bulb for about three minutes. Note the temperatures. Is there any difference? If so, in which case was more heat absorbed? Why do many people wear light colored clothing in the summertime?

You might try this thermometer experiment in direct sunlight, on concrete and on blacktop.

Have students research how radiant energy from the sun gives a tan or sunburn.

Grade Level: 4-6

Discipline: Science

Objective:

The student will be able to give examples of the conversion of energy from one form to another.

Suggested Time: One or two class periods

Materials Needed:

Activity Master and energy transformation illustrations that follow

Teacher Notes:

Energy can appear in several different forms, and can be changed from one form to another. In each transformation, there is a loss in the total amount of usable energy, with some energy being converted to waste heat. The most common forms of energy are heat, light, sound, mechanical, chemical, electric, gravitational, and nuclear. The two general categories of energy, encompassing all the various forms, are potential energy and kinetic energy.

Teaching Suggestions:

This activity game can be used either as an introduction to energy transformation or as a review tool. The illustrations that follow may be used to prepare for this activity. After the students know the definitions of energy and its forms, hand out the activity sheet. Explain the rules to the students and fill a few blocks with them for examples. A transparency may help. At the conclusion of the game, discuss with the students the fact that in changing from one form of energy to another, some energy is lost as heat. Examples: hot motor, hot brakes. Eventually all energy we use ends up as low grade heat (Second Law of Thermodynamics) which we cannot put to work and which is lost to the atmosphere and eventually to space.

Some possible examples are included in a completed copy of the activity master that follows.

ACTIVITY MASTER
INTRODUCTION: ENERGY TRANSFERRED

B A	LIGHT	SOUND	HEAT	MECHANICAL (movement)	ELECTRIC	CHEMICAL	NUCLEAR
LIGHT	X						
SOUND		X					
HEAT			X				
MECHANICAL (movement)				X			
ELECTRICAL					X		
CHEMICAL						X	
NUCLEAR							X

Adapted from pg 21, NSTA "Energy, Engine and the Industrial Revolution"

As you play this game fill in this chart with an example of each energy transformation when possible. Do this so that A form is changed to B form.

This game is to be played between two teams. The teacher will judge the answers and disputes. Team 1 and Team 2 are to alternately provide examples of energy changes to be filled in the chart above. Points can be gained or lost in the following manner:

1 point for a correct response
0 points if the team whose turn it is has no response
1 point for the opposing team if they dispute an incorrect example and can supply their own correct example. (The order of turns continues as normal)
-1 point for any wrong dispute. Only one dispute is allowed for each example.

The panel will decide on the awarding of points, referring to the teacher for help as needed.

Not all the blocks will have answers. The game is over whenever each team has not had any examples through two whole rounds.

ACTIVITY MASTER
INTRODUCTION: ENERGY TRANSFERRED

B A	LIGHT	SOUND	HEAT	MECHANICAL (movement)	ELECTRIC	CHEMICAL	NUCLEAR
LIGHT	X		Infrared Absorption	Photo-Electricity	Solar Cell	Photosynthesis Photochemical Reactions	
SOUND	To laser beam	X	Dissipates as heat	Motion of Molecules	Telephones Microphones		
HEAT	Light bulb Fire Electric Arc	Explosins	X	Steam Turbine	Thermionic Effects	Dissociation of Water	Nuclear Reactions in Stars
MECHANICAL (movement)	Non-Electric Sparks (e.g. Flint & Steel	Voice Muscial Instruments	Friction	X	Electric Generator		Cyclotrons
ELECTRICAL	Light Bulb Television	Radio Telephone	Toaster Iron	Motor	X	Storage Battery	
CHEMICAL	Firefly Fire	Explosions	Burning Fuels		Fuel Cell Storage Battery	X	
NUCLEAR	Nuclear Bomb	Nuclear Bomb	Nuclear Bomb Nuclear Reactor	Fission Fusion	Nuclear Bomb Nuclear Reactor	Nuclear Battery	X

Adapted from pg 21, NSTA "Energy, Engine and the Industrial Revolution"

As you play this game fill in this chart with an example of each energy transformation when possible. Do this so that A form is changed to B form.

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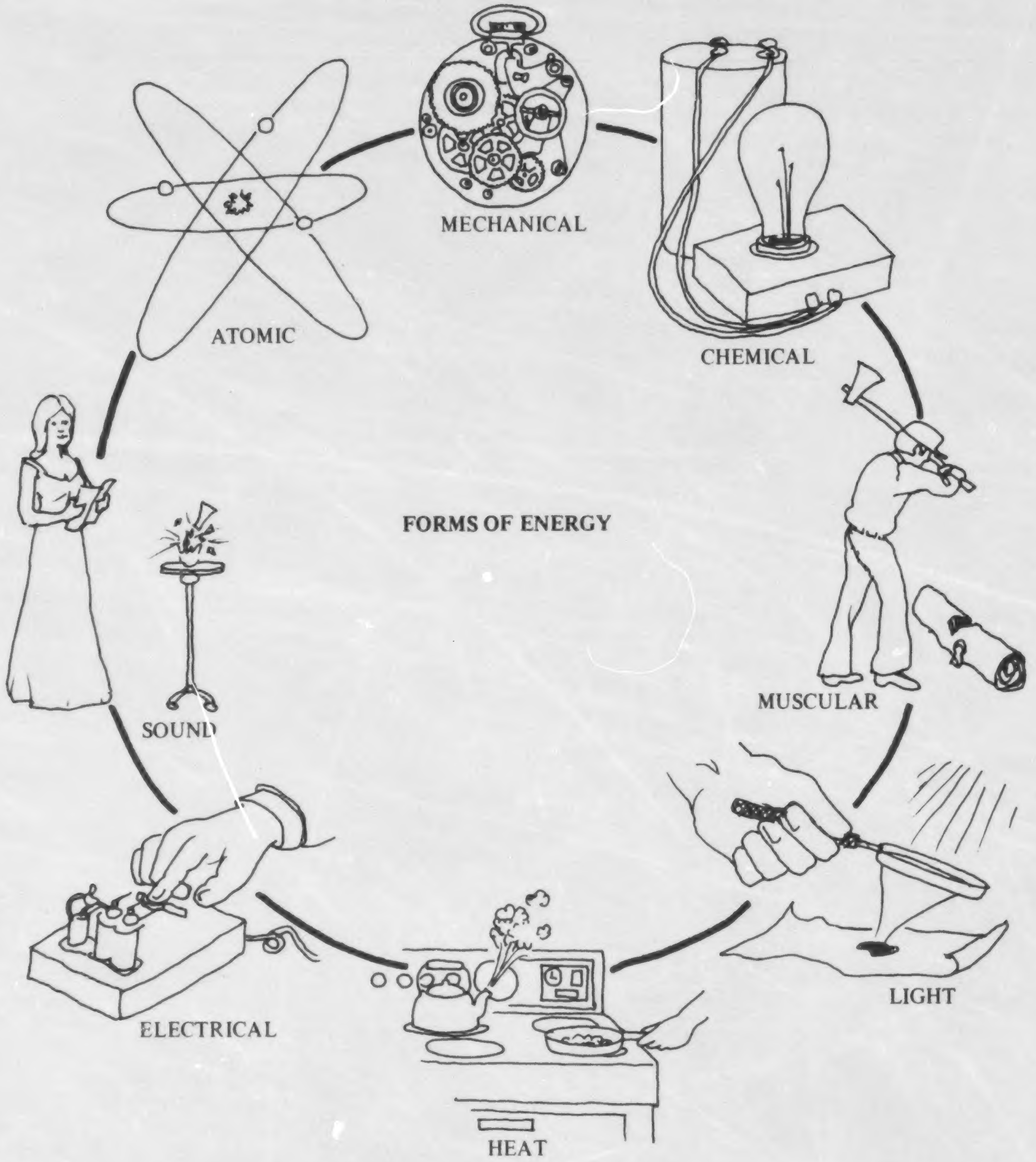
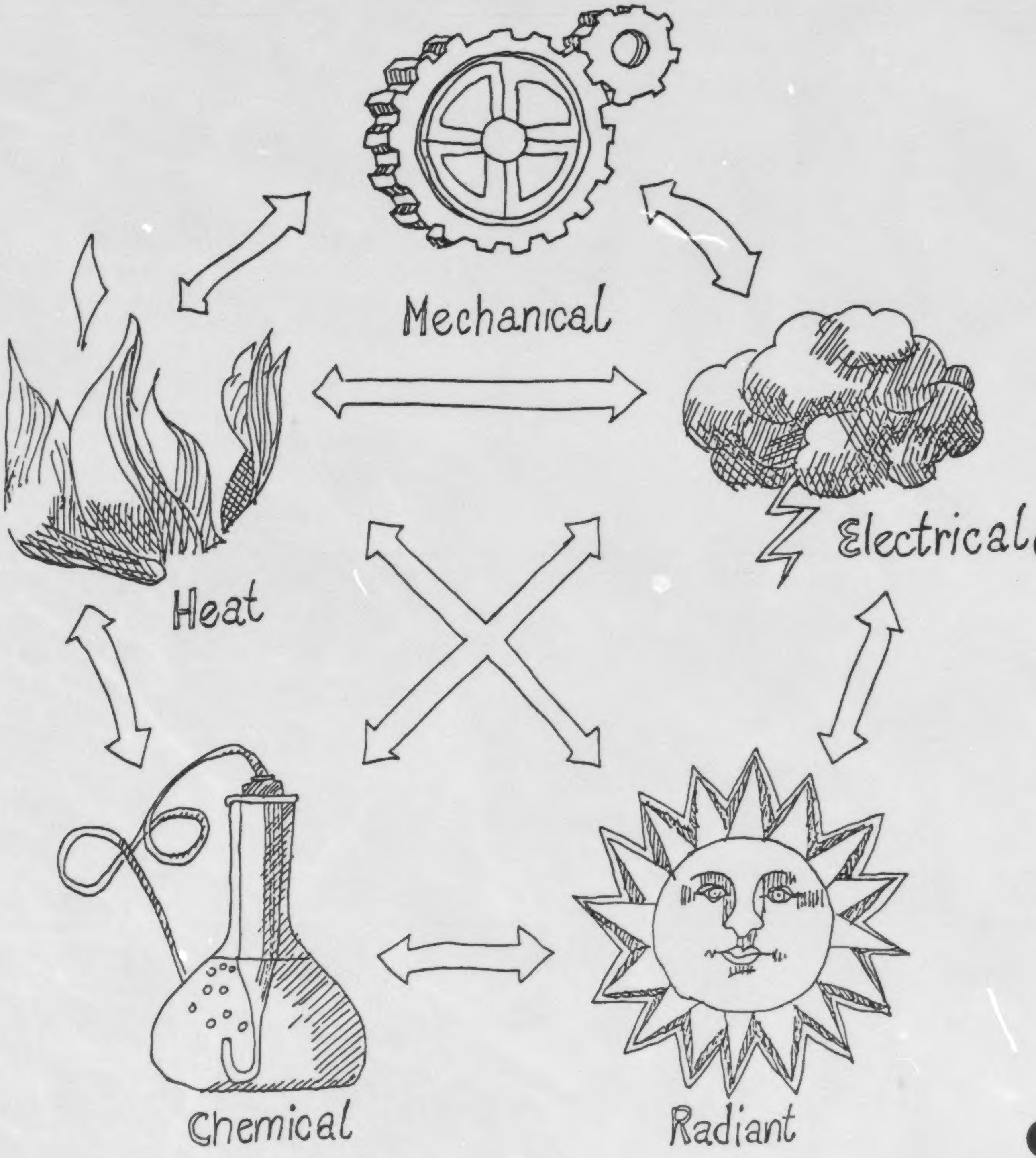
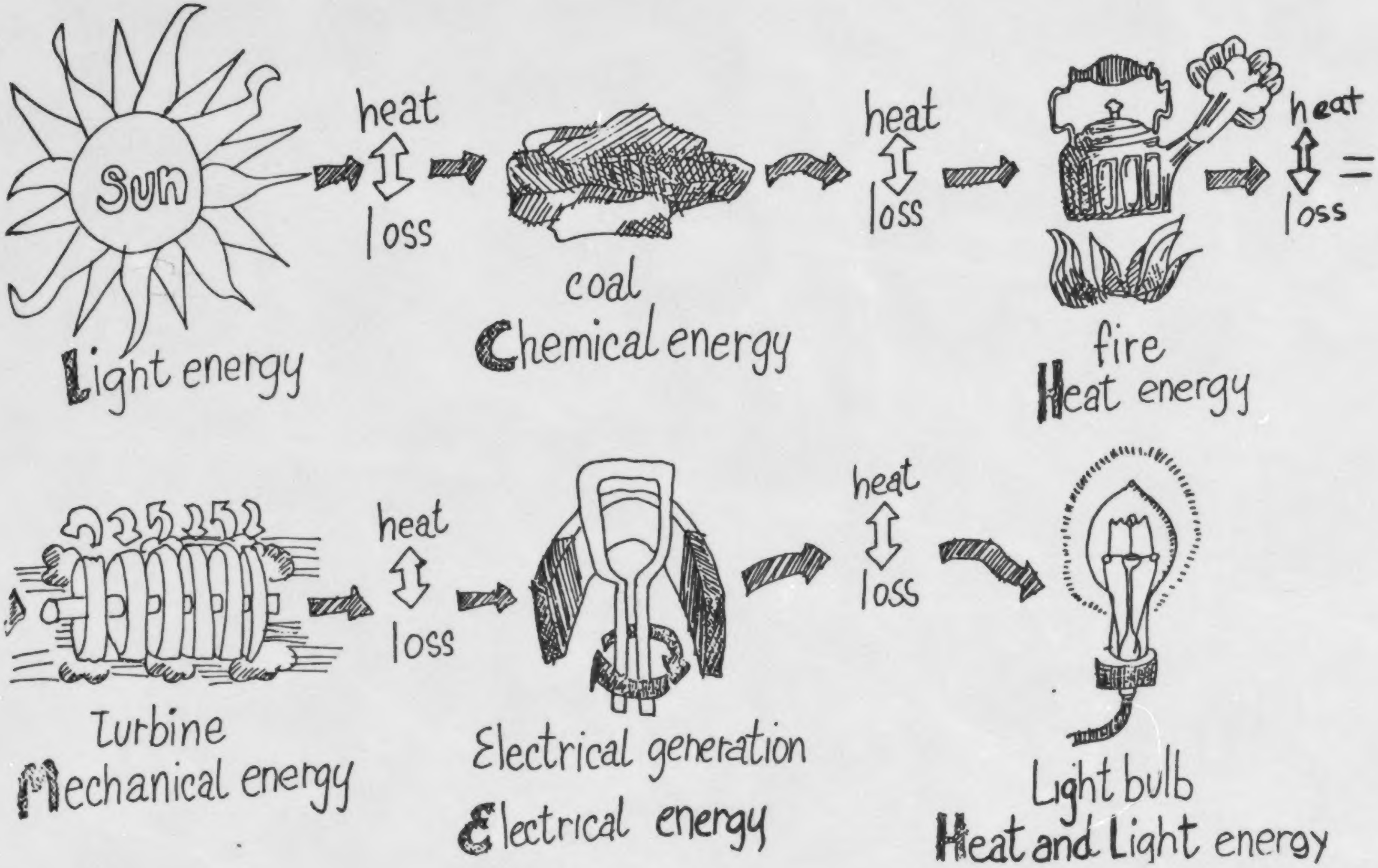

MECHANICAL
ATOMIC
CHEMICAL
FORMS OF ENERGY
MUSCULAR
SOUND
LIGHT
ELECTRICAL
HEAT

From: "Energy: Its Sources, Uses, Conservation (A Teacher's Resource)
Published by New York State Electric and Gas Corp., Binghamton, New York

ENERGY CHANGES FROM ONE FORM TO ANOTHER


Mechanical
Electrical
Heat
Chemical
Radiant

ENERGY TRANSFORMATION


Sun
Light energy
heat
loss
coal
Chemical energy
heat
loss
fire
Heat energy
heat
loss
=
Turbine
Mechanical energy
heat
loss
Electrical generation
Electrical energy
heat
loss
Light bulb
Heat and Light energy

Grade Level: 2 and 3

Disciplines: Language Arts, Science

Objectives:

The students will be able to describe the natural laws of energy, detect the natural laws at work in nursery rhymes and songs, and dramatize the natural laws of energy.

Suggested Time: 3–20 minute periods

Materials Needed:

Record of nursery rhymes or songs, wind-up toys, light bulb, egg

Teacher Notes:

Our present energy dilemma can be understood through an analysis of the natural energy laws, which scientists call the laws of thermodynamics. In simple form, these laws are as follows:

First Law: This is the law telling us that energy is conserved. Energy cannot be created or destroyed, it only changes form. This is the *good news* law about energy. People, animals, and machines convert energy from one form to another.

Second Law: The flow of energy is from order to disorder. It goes in only this one direction and cannot be recycled. This is the *bad news* law of energy: You can't win; you can't even break even, because energy is continually becoming less usable. The energy is not being destroyed–it is simply changing into a less usable form, generally heat. Just as you can't put a broken egg back together, you can't make *disordered* energy *ordered* again. This law also states that heat goes from a hot object to a cold object until both reach the same temperature.

These laws present the following challenge to us: We must expend effort to keep up our supply of energy resources, since once the energy is used, it cannot be used again. And we must conserve the energy we have and use it more efficiently and wisely so that we will have energy supplies for a longer period of time.

Teaching Suggestions:

Play a record of nursery rhymes or songs. Read or have the students recite *Jack and Jill, Humpty Dumpty, Hush-a-bye Baby,* and *London Bridge.* They could also play the game *London Bridge is Falling Down.* Discuss the nursery rhymes and what they say. Point out that they also tell us something about the laws of energy. Discuss *Jack and Jill* and *Hush-a-bye Baby* in terms of the first law of energy:

> Where do Jack and Jill get the energy to go up the hill? (From the food they ate) The sun helps the plants grow to provide the food we eat. The sun is our original source of energy; we are only energy converters.
>
> How did the cradle rock in Hush-a-bye Baby? (the wind pushed it)

Discuss what happened to Jack and Jill, Humpty Dumpty, and the baby when the bough breaks in terms of the second law:

What happens when Jack and Jill fell down the hill? It was sort of a mess, wasn't it? What happened to Humpty Dumpty? A real shambles! Could you make Humpty Dumpty whole again? (At this point, illustrate by breaking an egg into a dish.) Explain that this is what happens to energy as we use it. Some of it is wasted, becomes a shamble, and we can't use it again. Discuss wasted heat by having the students put their hands over an incandescent light bulb to feel the wasted heat.

Discuss *London Bridge* and *Jack and Jill* in terms of the challenge these laws give us:

How do we fix London Bridge when it falls down? or Jack's crown? (We build the bridge up and mend Jack's head.) That takes some effort on our part, doesn't it? It's the same way when we use energy. It takes an effort to keep our light bulbs burning' it takes a lot of effort to get the oil and coal out of the ground. And we keep having to get more and more because we waste a lot. Use wind-up toys to illustrate this challenge–without continued winding, they soon run down.

Additional Activities:

Dress up in a costume of a robot with a wind-up key. Pantomime an activity that the robot does until he winds down. Then have a student wind him up again. You could also dress up as the Tin Man and have to be oiled when you get rusty and stiff.

Have the students dramatize or pantomime the laws of energy.

JACK AND JILL WENT UP THE HILL
TO FETCH A PAIL OF WATER;
JACK FELL DOWN AND BROKE HIS CROWN,
AND JILL CAME TUMBLING AFTER.

HUSH-A-BYE, BABY, ON THE TREE TOP,
WHEN THE WIND BLOWS,
THE CRADLE WILL ROCK,
WHEN THE BOUGH BENDS,
THE CRADLE WILL FALL,
DOWN WILL COME BABY, CRADLE, AND ALL.

HUMPTY-DUMPTY SAT ON A WALL,
HUMPTY-DUMPTY HAD A GREAT FALL,
ALL THE KING'S HORSES,
AND ALL THE KING'S MEN,
COULDN'T PUT HUMPTY TOGETHER AGAIN.

LONDON BRIDGE IS FALLING DOWN,
FALLING DOWN, FALLING DOWN,
LONDON BRIDGE IS FALLING DOWN,
MY FAIR LADY.

BUILD IT UP WITH IRON BARS,
IRON BARS, IRON BARS,
BUILD IT UP WITH IRON BARS,
MY FAIR LADY.

OLD MOTHER HUBBARD WENT TO THE CUPBOARD,
TO GET HER POOR DOG A BONE:
BUT WHEN SHE GOT THERE, THE CUPBOARD WAS BARE,
AND SO THE POOR DOG HAD NONE.

(the moral!)

VI.

Present Energy Sources, Their Supply Limitations and Environmental Problems

Grade Level: 5, 6

Disciplines: Social Studies, Language Arts

Objectives:

The student will identify some of the environmental and safety problems of mining and burning coal, and mining uranium and operating reactors, to generate electricity.
The student will make decisions as to whether coal or nuclear energy should be used to generate electricity.

Suggested Time: Three to four class periods

Materials Needed:

Court trial script that follows, pictures showing positive and negative sides of coal mining, uranium mining, nuclear and coal fired power plants, background materials for research

Teacher Notes:

Over half of the total amount of coal consumed yearly in Pennsylvania is used to generate electricity. This is supplemented by 6 percent of the oil consumed yearly in-state and all of the existing nuclear and hydroelectric capacity. The Commonwealth's generating capacity is evolving toward a coal/nuclear mix due to the restrictions of the National Energy Act and the availability problems of oil and natural gas. Coal is burned and nuclear fuel is allowed to fission to provide the heat necessary to generate steam. The steam is forced over the turbine blades of an electric generator, causing them to rotate. This in turn rotates a large magnet inside a coil of wire which forces the electrons in the coil to move. This flow of electrons is transmitted through wires as electrical energy.

There are environmental problems associated with electricity produced by both coal and nuclear power. In both processes, the steam has to be condensed back to water to be pumped back into the boiler for reuse. Cold water is used for this process, and is provided from river water, cooling ponds, or cooling towers. If river water is used, the subsequent rise in temperature may affect aquatic life. Cooling towers may affect the atmospheric temperature and humidity.

The proper disposal of waste products in the form of suflur from coal and oil plants, particulate matter from coal-fired facilities, and radioactive wastes from nuclear plants is essential for the safe operation of power facilities. Wet scrubbers are used to remove sulfur from the emissions of coal-burning plants, but such scrubbers are expensive and still not perfected. Spent fuel rods from nuclear facilities must be isolated to prevent radioactive material from entering the environment. These wastes are currently being stored on site since there are no commercial disposal areas for the spent fuel rods.

The mining of coal is a difficult and dangerous occupation. Methane gas explosions, accidents, and black lung disease from the coal dust are all risks the miners must take. When uranium is mined, uranium tailings are left and remain radioactive for hundreds of years. This poses a threat to those who build homes and places of business over or near them.

Teaching Suggestions:

You may want to use the following script in its entirety to insure that the major points are covered. However, it is possible that the students will be able to develop their own parts after completing some research.

Find out how many students have watched a court trial in a courtroom or on TV. If there are many who do not know what a court trial is, you might want to arrange a field trip to see a trial. Ask: Why do people have trials? Is a trial a fair way to decide an issue? Suggest that the class hold a trial, but instead of trying a criminal they should try the two predominant sources of electricity, coal and nuclear energy. The case should decide which source is better to use from an environmental standpoint.

Describe the roles in the trial and assign students to each role. Point out that in real trials the jury does not hear the evidence ahead of time, but must make their decision when the case is presented. You might want to have the jurors work on some other activities until the case is presented. Each participant, depending on his/her role, should then do research which will help him/her present the case. Some research topics are black lung disease, coal mining methods, uranium mining methods, location of coal and uranium, how coal pollutes, how nuclear energy is produced, problems of uranium tailings, and air pollution problems associated with the burning of coal.

On the day of the trial, set up the classroom to simulate a courtroom. You might put a flag near the judge's bench, and have a Bible available near the witness box. The judge could wear a robe and have a gavel.

After the verdict, discuss the following questions:

Which side, prosecution or defense, made the best presentation?
How did the use of facts help?
What evidence was not used that should have been used?
Why was it hard for the jury to make a decision? (Maybe it was a hung undecided jury.)
Do you think the decision should be appealed to a higher court? Why?
Can you write a trial to determine whether solar, wind, or other new technology could be used to generate electricity? What problems might you have to bring before the jury?

THE TRIAL SCRIPT

The Bright Lite Power Co.
vs
The People and Their Environment

Judge (1) A serious minded person, wears a dark robe and carries a gravel. This person is very fair.

Lawyers (5) Five courtroom lawyers, wear coats and ties (or dressy pants or dress), carry briefcases with evidence in them. They have name tags with Esq. after their name.

Witnesses Students acting as engineers, coal miners, scientists, government officials, uranium workers, citizen with cancer.

Jurors (12 or more) Civil cases do not require 12, but use as many as needed. They should represent the people in the area and should be approved by the lawyers on both sides.

Reporters (4) Two newspaper and two TV camermen (not allowed inside courtroom when court is in session), newspaper artist.

Court Reporter Played by the teacher, who must keep a record of the key points made by both sides. (might use a tape recorder)

Spectators Remaining class members

PROCEEDINGS

Court Reporter (banging a gavel) All rise for the entrance of the judge.
(Judge enters) Jurors may take their seats. This is the case of the Bright Lite Power Co. vs The People and their Environment

You may be seated.

Judge Coal and nuclear energy are dependable sources for making electricity, but we use both at great risk to our environment and health. Let's look at the environmentalists' side of the story and then we shall listen to the coal and nuclear power experts and hear their side of the story. Lawyers for the environmentalists, would you state your case?

Lawyer 1
Environmentalist Coal and nuclear energy are the two primary sources used in Pennsylvania to generate electricity. Water power is not possible because we cannot build any new dams. We are using up our oil and natural gas reserves and must keep them for other purposes. Many people depend on electricity in their homes and on their jobs. But getting the coal from the ground hurts the environment. Strip mining damages large areas of land. A huge machine removes the soil to get the coal. This kind of mining causes erosion of the land. Often there are landslides and falling rocks.

I would like to introduce Exhibit A (Hold up picture of strip mining). Underground mining is damaging also. Water seeps into the abandoned mines and mixes with sulfur from the coal to make acid mine drainage which kills fish and often colors the stream red.

Ladies and Gentlemen of the Jury, coal mining is also dangerous to the miner's health. Black lung disease has cost the miners the loss of their money and their lives. Coal miners usually have short life spans. Many miners get hurt in mine accidents, too. I would like to call Mr. ______________ who has returned from Mine No. 5 because he has black lung disease.

Coal Miner Witness (coughing while talking) I have worked in No. 5 mine for 25 years. I narrowly avoided being killed when I first started working in the mine because part of the mine caved in. Then, last year, I got black lung disease from breathing the coal dust. It is a disease, the doctors tell me, which gets worse each year, and I will no longer be able to work. I tell my sons not to work in the mines. Even though they now train miners to avoid accidents and the pay is good, it is too dangerous a job.

Lawyer 1
Environmentalist You have just heard the hazards in mining coal. Making electricity with coal is another problem. Burning coal in power plants gives off hot gases, particulate matter, and sulfur which makes the air dirty. The sulfur combines with the water vapor in the air to make something that smells like rotten eggs and affects the respiratory system. Carbon dioxide, another substance, is given off and some scientists believe that it changes the climate.

The coal wastes, or ash, are hazardous materials and have to be disposed of carefully. The hot water generated when steam is produced from the burning coal is dumped into nearby rivers and lakes, changing the enrivonment of the plants and animals that live there.

I would like to introduce Exhibit B (picture of smoke stack on power plant)

Even after the electricity is made, there are environmental problems. Ladies and Gentlemen of the jury, you have seen utility poles carrying high tension lines. You know how ugly they are! These utility poles and miles of cables needed use up a lot of land. When these high tension lines interfere with your favorite TV program, then, members of the jury, something must be done!

Lawyer 2
Environmentalist Nuclear power is used primarily to make electricity from steam in large power plants. Uranium is the basic fuel and is found in ores and mined in the western part of the United States. In the mining of the uranium ore, uranium tailings are buried in the ground. Because uranium is radioactive for a long period of time, it can be dangerous to the health of those people living on sites where the uranium tailings are buried. I would like to call a witness.

Witness (young woman with gray hair) My name is Mrs. _______________ and I am 29 years old and have 3 young children. I live in Grand Junction, CO. The radioactivity readings where I live are high due to the burial of uranium tailings under the town. The doctors have just told me that I have leukemia, a form of cancer of the blood, and only have a few years to live. Who is going to raise my children?

Lawyer 2
Environmentalist Ladies and Gentlemen of the Jury, you have just heard about the kind of health problems that can occur in uranium mining. There are other problems in the generation of electricity. One is a problem of waste heat. Nuclear power plants have more waste heat than coal fired plants and discharge all their waste heat into the cooling water. This cooling water can kill the fish in nearby streams or oceans if it is too warm when put back into these streams after absorbing the waste heat from the nuclear reactor. Some scientists also believe that radiation is higher around nuclear power plants. I would like to submit Exhibit C (pictures of cooling tower and nuclear reactor).

But the biggest problem is what to do with the nuclear wastes or used fuel from these power plants. These wastes are stored in steel drums near the power plants. They are poisonous and dangerously radioactive for millions of years. The government has not made a decision as to where they will store these wastes for the life time that they are radioactive. Most states do not want them stored anywhere near the people that live in their state. Future generations may suffer if a solution is not found to this problem in the next few years. We cannot let that happen!

Judge Members of the jury, you have heard the case for the environmentalists arguing against the production of electricity by coal or nuclear power. Since this is a special case, I will now open the court to questions from the jury. Are there any questions? (after the questions) Could we hear a summary of the environmentalists' case?

Court Reporter (reads notes or plays back tape on the environmentalists presentation)

Judge Now we will hear the case for the utility companies. First we will hear testimony from the Many-County Coal Mining Company. Lawyer, would you state your case?

Lawyer
from the Coal Company Ladies and Gentlemen of the jury, I am here to show you and the people that coal mining is different today.

We need coal. We have an abundance of it in this state. Coal is used to make electricity for your TV and your kitchen appliances. Without coal many people would not have electricity for light.

We know that strip mining leaves ugly scars on the land. The coal mining companies now are bound by state law to restore the land to its natural and usable state.

I would like to introduce Exhibits D and E (show and describe picture of replanted land and recreation area). Also, in 1970, the United States Congress passed the Coal Mine Health and Safety Act. Ladies and Gentlemen, all coal mining companies today spend a lot of time and money improving the working conditions of their miners and training them how to mine the coal so that our safety records are much, much better. Members of the jury, I rest my case.

Judge Now we will hear from the lawyer from the nuclear power industry

Lawyer from the nuclear power industry We have to use more electricity to keep our economy going! We need more large nuclear power plants so that we won't be dependent on foreign countries for our energy supplies.

It is cheaper to produce nuclear power than it is to produce power from coal; also, it doesn't cause any air pollution problems.

Nuclear power plants produce less radiation than your color TV set does or the granite in buildings in New York City.

I would like to present Exhibit F (computing your own radiation dose). Our safety record is excellent. Even considering the infamous Three Mile Island accident, no member of the public has suffered physical harm from a nuclear power plant. Stations show that this is not true for coal.

As for the storage of radioactive wastes, we have that problem solved. May I call on an expert witness to address that problem: Prof_____ _______ from ________________________ University will you please come to the stand?

Witness Scientific Expert My name is Prof. _________________. I am a nuclear engineer from _______ ______________________ University. We have done many studies on the storage of long term radioactive wastes and our pilot program in Nevada shows that making the wastes into a solid and storing them in underground salt formations will protect those wastes from ever leaking any radiation into the atmosphere. We have presented our findings to the government officials.

Judge Thank you Prof. __________________. May we now hear from the lawyer representing the Bright Lite Power Company.

Lawyer 5 Utility Company Our company is now following the guidelines that were passed by Congress. The Water Quality Act sets the standards for water quality. The Clean Air Act and its Amendments set the guidelines to follow for controlling air pollution. We have put scrubbers on our plants to clean the air. Protecting the environment costs us lots of money, but we are willing to live with the law.

I would like to introduct Exhibit G (utility wires)

Now many cities are placing the high tension lines underground. This way the land can be used for better things. The land is pretty without the utility poles. But ladies and Gentlemen, remember, that with any source of fuel used to generate electricity, there will be environmental problems.

Judge Do the members of the jury have any questions for these lawyers? (Answer questions) Could we have a summary of the case for the coal and nulcear utility companies?

Court Reporter (read or plays the notes of the coal company and power company representatives)

Judge The jury is excused to deliberate. Remember your charge is to decide which source of generating electricity is better to use and protect the environment. The court is in recess. (bangs his/her gavel. All rise as the judge leaves)

Jury (Debate the issue and vote by a show of hands. A unanimous vote decides the case. If the jury cannot reach a decision then it is a hung jury and they tell the judge that they have not been able to reach a decision. One juror should be elected to tell the court when they reach a verdict.)

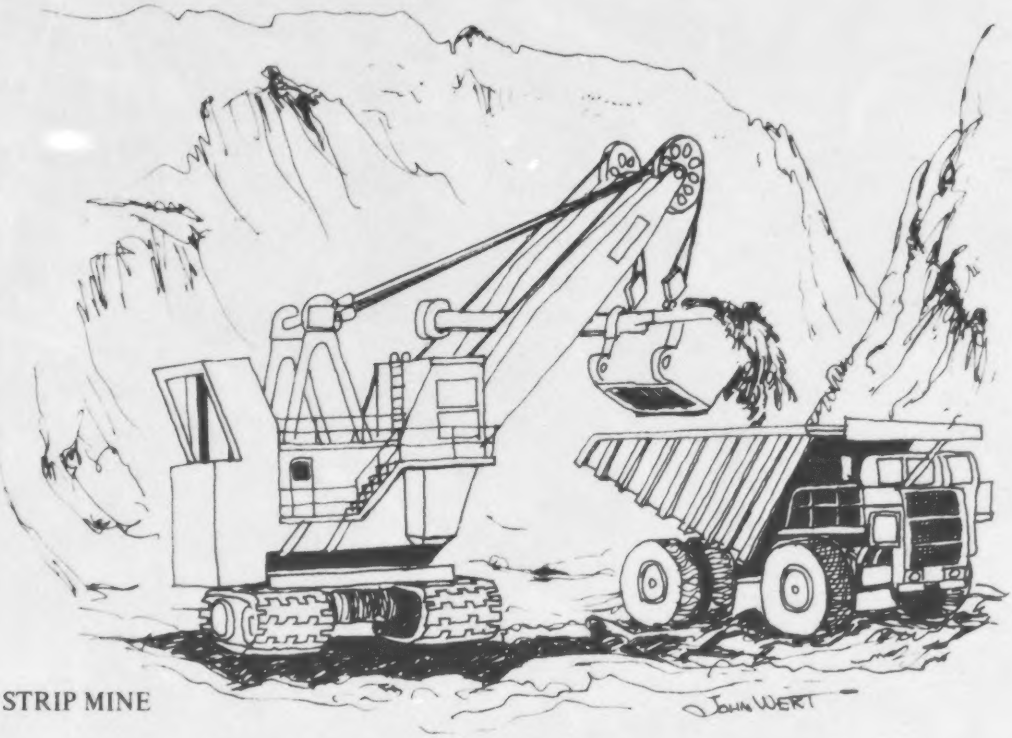
Court Reporter All rise (specators rise for the judge and jury who enter the courtroom)

Judge Jury, have you reached a verdict?

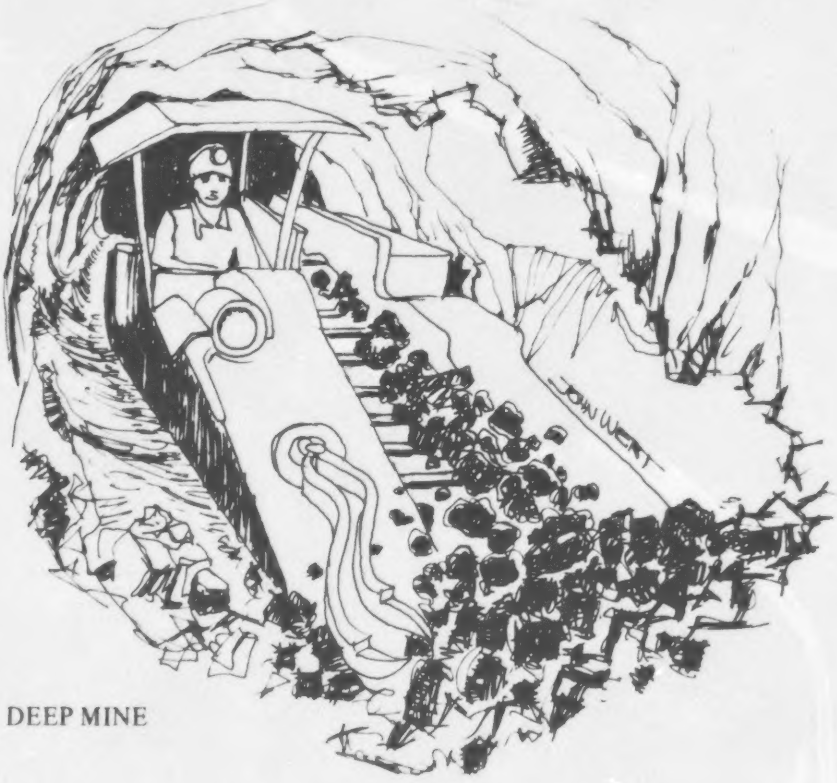
Jury Spokesperson We have, Your Honor (gives verdict)

Judge (sums the verdict up again, the excuses the spectators and everyone else). Court is adjourned.

Court Reporter All rise (judge leaves) You are excused

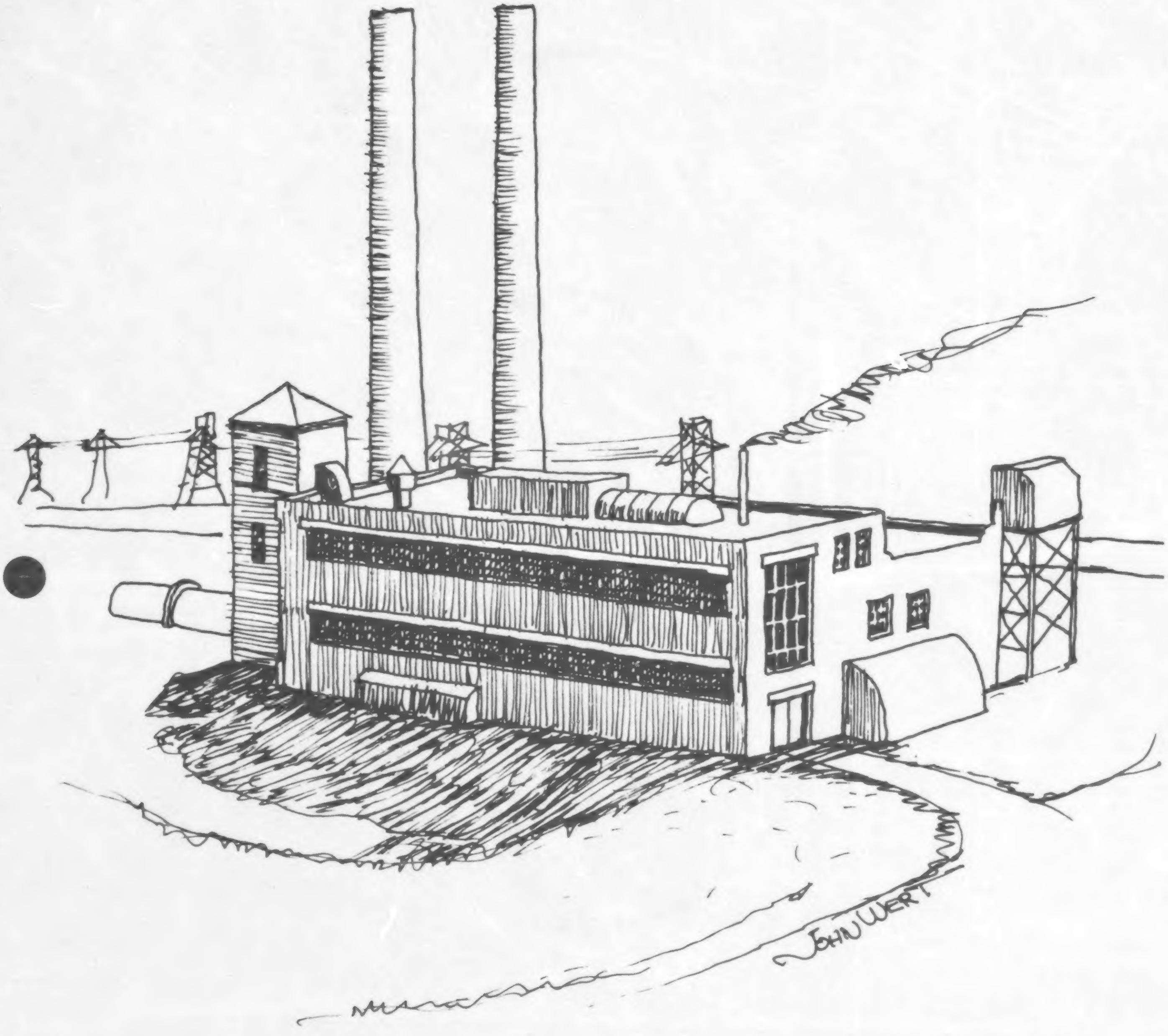


STRIP MINE



DEEP MINE

EXHIBIT A



POWER PLANT SMOKE STACK

EXHIBIT B

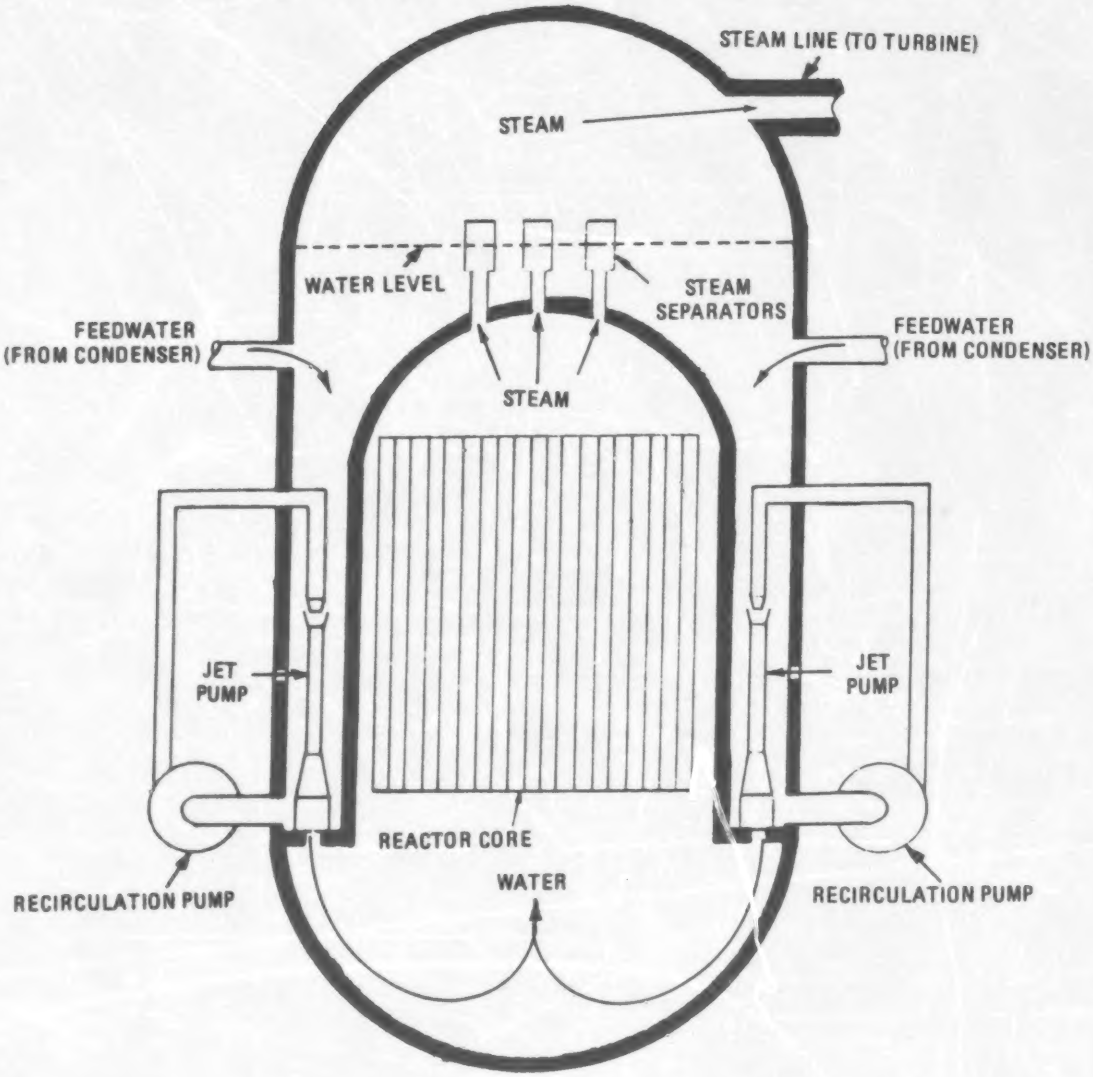

STEAM LINE (TO TURBINE)
STEAM
WATER LEVEL
STEAM SEPARATORS
FEEDWATER (FROM CONDENSER)
FEEDWATER (FROM CONDENSER)
STEAM
JET PUMP
JET PUMP
REACTOR CORE
RECIRCULATION PUMP
WATER
RECIRCULATION PUMP

FIGURE 12
SCHEMATIC ARRANGEMENT OF BOILING WATER REACTOR

EXHIBIT C

77

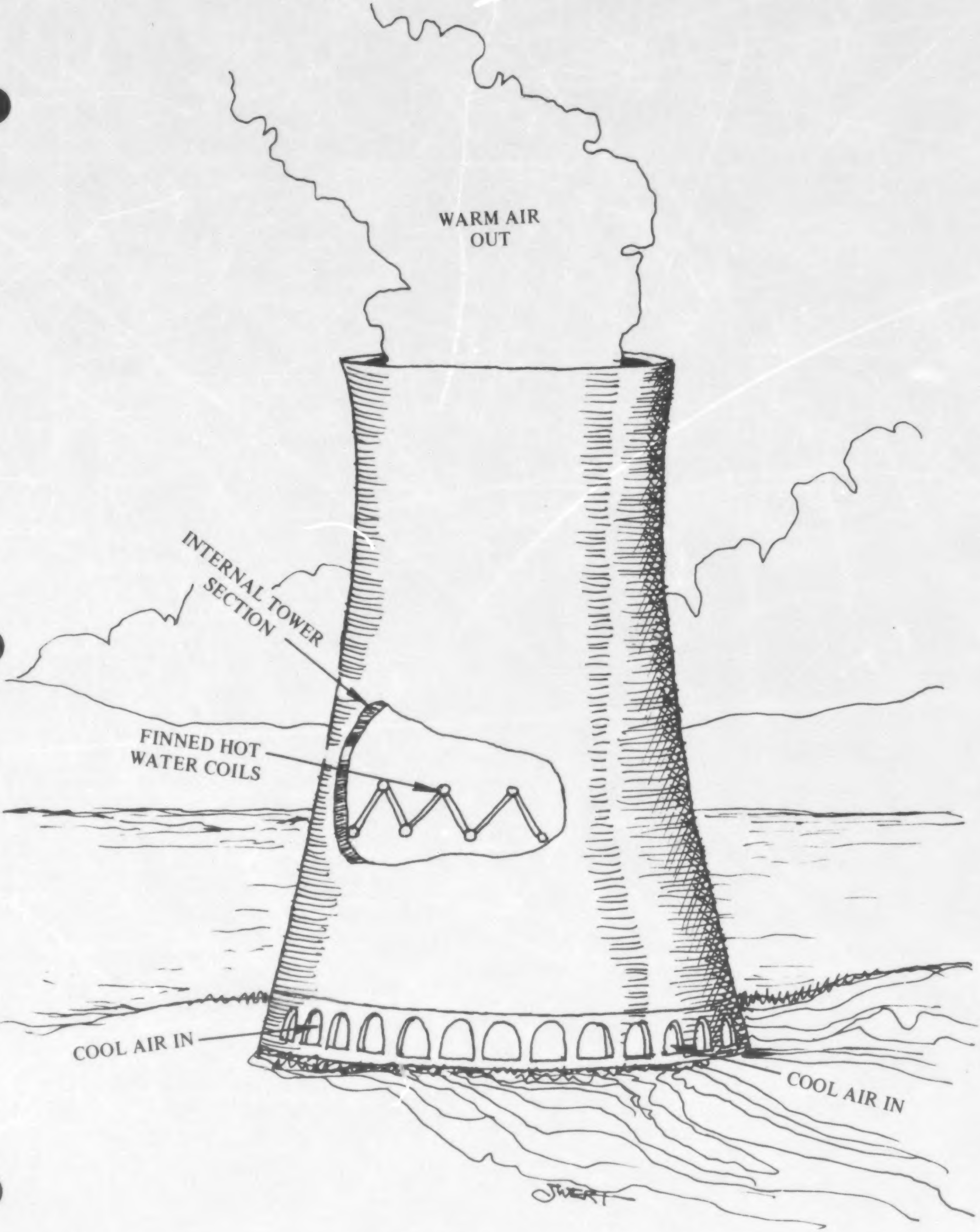
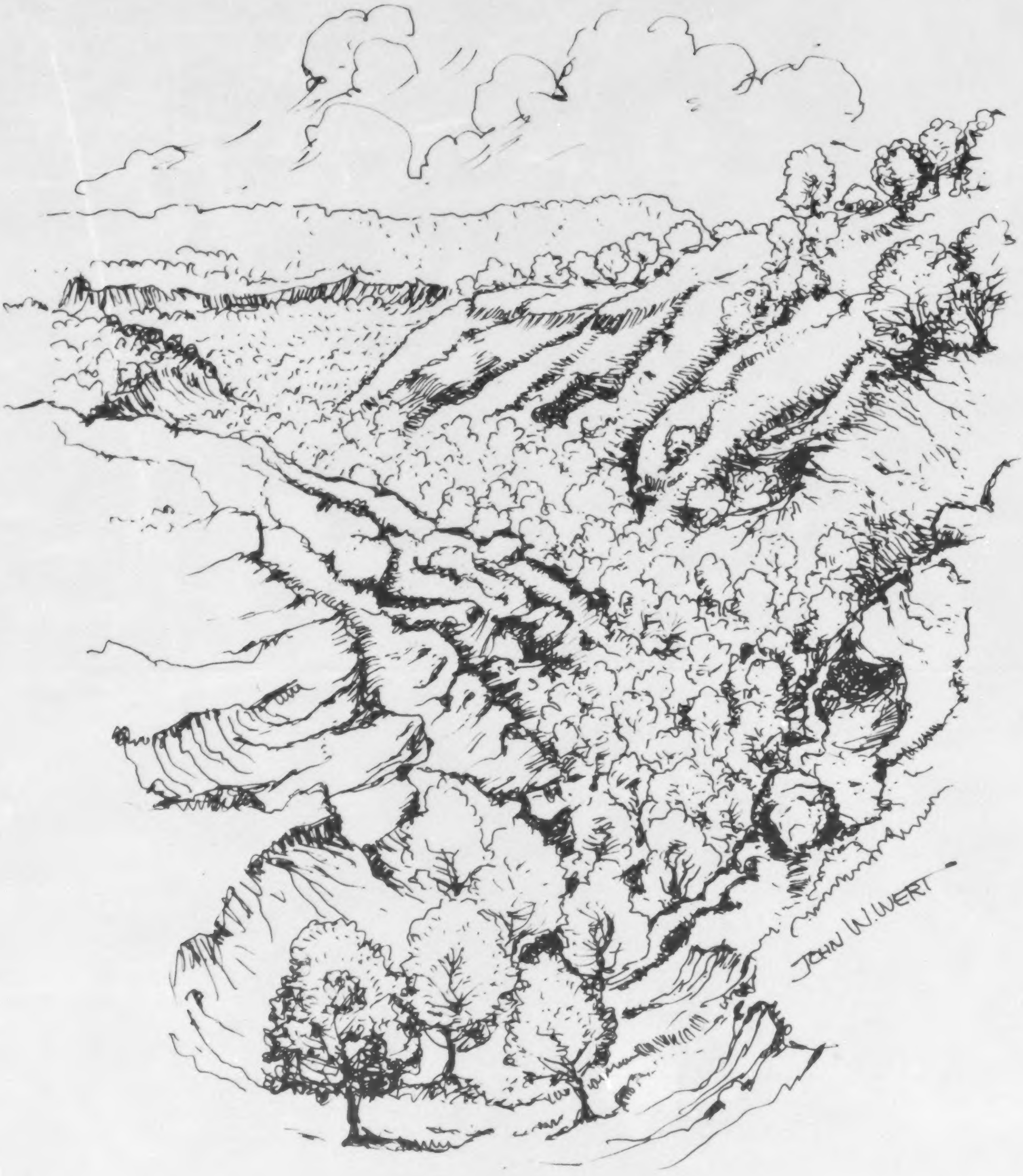

WARM AIR OUT
INTERNAL TOWER SECTION
FINNED HOT WATER COILS
COOL AIR IN
COOL AIR IN
SWERT

EXHIBIT C
COOLING TOWER



Hillside of a coal mine is being planted with trees and grass.

EXHIBIT E

COMPUTE YOUR OWN RADIATION DOSE

We live in a radioactive world. Radiation is all about us and is part of our natural environment. By filling out this form, you will get an idea of the amount you are exposed to every year.

	Common Source of Radiation	Your Annual Inventory		Percent*
WHERE	Location Cosmic radiation at sea level (Ret 5-4) Elevation Add 1 for every 100 feet of elevation Typical elevations Pittsburgh 1200: Minneapolis 815: Altanta 1050: Las Vegas 2000: Denver 5280: St. Louis 455: Salt Lake City 4400: Dallas 435: Bangor 20: Spokane 1890: Chicago 595 (Costal cities are assumed to be zero, or sea level.)	44 ----		29.7
YOU	House construction (based on 3/4 of time indoors) (Ref. 5-5) Brick 45 Stone 50 Wood 35 Concrete 45	----		27.0
LIVE	Ground: (based on 1/4 of the time outdoors): U.S. average	15		10.1
WHAT YOU EAT, DRINK, & BREATHE	Water Food U.S. average Air (Ref. 5-9)	25		16.9
	Weapons test fallout (Ref. 5-4)	4		2.7
HOW	X ray diagnosis (Ref. 5-7) Chest X ray ---- x 9 Gastrointestinal tract X ray ---- x 210	----		13.5
YOU	Jet airplane travel (Ref. 5-8) Number of 6000-mile flights ------ x 4	----	0.1%	100
LIVE	Television viewing (Ref. 5-6) Number of hours per day ----- x 0.15	----	0.1%	
	Compare your annual dose to the U.S. Annual Average of 148 mrem	----		
HOW CLOSE YOU LIVE TO A NUCLEAR PLANT	At site boundary Annual average number of hours per day ---- x 02 One mile away Annual average number of hours per day ---- x 002 Five miles away Annual average number of hours per day --- x 0002 Over 5 miles away None	---- ---- ----	Less Than 0.1%	
			mrem Total	

One mrem per year is equal to:
Moving to an elevation 100 feet higher.
Increasing your diet by 4%.
Taking a 4- to 5-day vacation in the Sierra Nevada Mountains.

*** Table 5-11 The bar graph (at the right) shows the source percentages of the 148 mrem, U.S. average annual radiation dose. Use the table to compute and compare with them your own dose and its make-up.**

EXHIBIT F

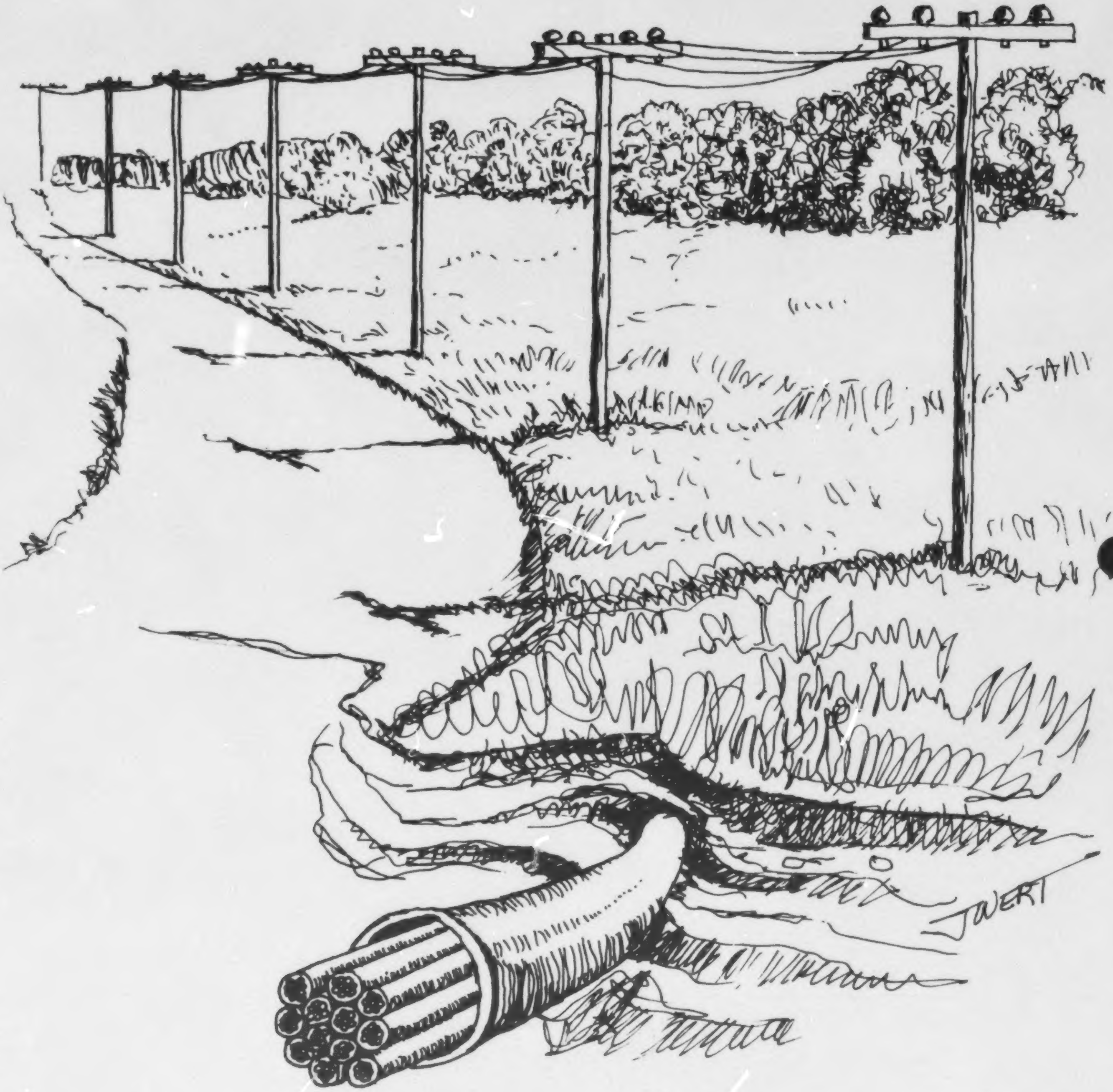


EXHIBIT G

Grade Level: 4-6

Discipline: Science, Social Studies, Language Arts

Objective:

Students will complete a puzzle using energy words

Suggested Time: One class period

Materials Needed: "Energy Words" puzzle that follows

Teaching Suggestions:

Students should complete the puzzle. Discuss the definitions of the words.

ENERGY WORDS

A	E	F	D	T	L	I	O	A	S
O	N	U	S	B	G	H	C	M	A
T	H	G	I	L	A	B	U	Z	G
N	Y	A	P	Z	S	E	D	S	L
W	G	Q	R	H	L	P	T	Q	A
T	R	W	O	O	D	A	L	R	R
L	E	N	R	C	E	L	A	T	U
E	N	T	G	H	S	I	O	P	T
S	E	I	R	O	K	J	C	M	A
P	L	M	T	N	H	T	H	D	N

LOCATE THE WORDS AND CIRCLE

Be Careful – Some Are Backwards

and Some Are Diagonal

*GAS
*HEAT
*OIL
*LIGHT
*ENERGY

*SUN
*PETROLEUM
*NATURAL GAS
*WOOD
*COAL

Grade Level: 5, 6

Discipline: Science

Objectives:

The student will be able to give a simple explanation of two types of nuclear energy, fission and fusion.

Suggested Time: One class period

Teacher Notes:

Nuclear energy is the energy that is released or absorbed during changes within the nucleus of an atom. Two important forms of nuclear energy are fission and fusion.

When certain relatively large atoms such as some forms of uranium are bombarded by particles called neutrons, the atoms split into smaller atoms. Huge amounts of energy are released in this process, and this energy appears as heat. The heat can be used to boil water to make steam, which spins turbines that generate electricity.

Nuclear fusion is still being developed as an energy source, and its practical use is far in the future. In fusion, relatively small atoms, such as hydrogen, are forced together to form larger atoms, releasing tremendous amounts of energy.

Teacher Suggestions:

The various roles and movements in these illustrations should be worked out in advance with the participating students so that the situation does not become ineffective or get out of hand.

In order to illustrate fission, ask two students to each hold one hand of the teacher. These students represent the uranium atom, and the teacher represents the energy holding it together. Now ask the students to try to get away, but the teacher should hold them tightly so that they cannot. Then have a third student force them away from the teacher. What type of particle does the third student represent? (Neutron)

In illustrating fusion, the teacher tries to keep two students apart who are trying to get together. The third student makes every attempt to get the students together and finally succeeds in doing so. What do the students represent? (The two students trying to get together represent hydrogen atoms. The third student represents the energy it takes to get them together.) What does the teacher represent? (The energy that is released when they combine.)

Additional Activities:

Take the students on a field trip to a nuclear power plant to learn about and observe first hand a nuclear plant facility, its built-in safety features, and its potential for production of electrical energy. Students should be well-prepared in advance for such a trip.

Grade Level: 5, 6

Discipline: Science

Objectives:

The students will be able to illustrate hydroelectric power.

Suggested Time: 30 minutes

Materials Needed:

Cardboard, toothpick, thread, paper clips, gallon plastic milk container, one-hole stopper, two-inch length of glass tubing, two-foot piece of rubber tubing, medicine dropper

Teacher Notes:

One of the earliest forms of energy used by humans was the energy of flowing water. If you travel around the country, you can still see early water wheels which transformed the energy of flowing water into mechanical energy to grind wheat, run textile mills, and do other forms of useful work.

The potential (stored) energy of water is converted to kinetic (motion) energy as the water falls. Water power is an important source of electrical power. Huge dams have been built on our largest rivers to harness this form of energy. Next to these dams are hydroelectric power plants which use the falling water to spin the fan-like blades in turbines. These moving blades make huge magnets whirl past coils of wire, creating electricity that is sent out for distribution to homes, factories, schools, and cities.

Teacher Suggestions:

In this activity, the student will demonstrate that falling water can do work.

Cut four slits in a circle of cardboard and fold back the edges, as shown below. Push a toothpick through the center of the circle. Now you have a water wheel. The toothpick is the shaft. The folded parts are the blades.

Fasten one end of a thread about 8' long to a chain of three paper clips. Tie the other end of the thread to the shaft of your water wheel. Be sure it is tied tightly enough to keep from slipping.

Place the edge of the wheel under a stream of water. Hold the ends of the toothpick lightly between your fingers. The water will turn the wheel. The thread will wind up on the shaft and pull the chain of paper clips along with it. Did the water do any work? What kind of energy did it use?

Additional Activities:

Visit an old restored mill which has a water wheel in operation. Observe the movement of the water in a nearby stream.

Observe banks and slopes, after a rain storm if possible, to see the effects of moving water on soil and rock particles.

Use a garden hose to move objects on the playground.

View motion pictures showing dams, hydroelectric plants, moving water, ocean tides.

Cut four slits in a circle of cardboard and fold back the edges, as shown below. Push a toothpick through the center of the circle. Now you have a water wheel. The toothpick is the shaft. The folded parts are the blades.

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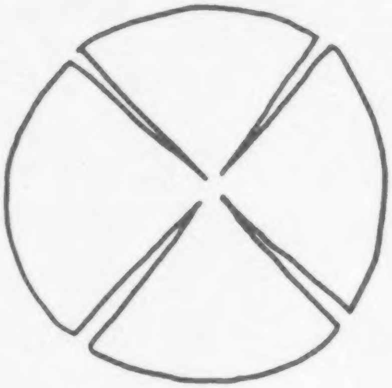
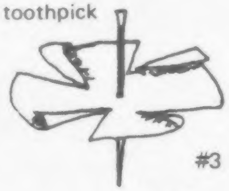
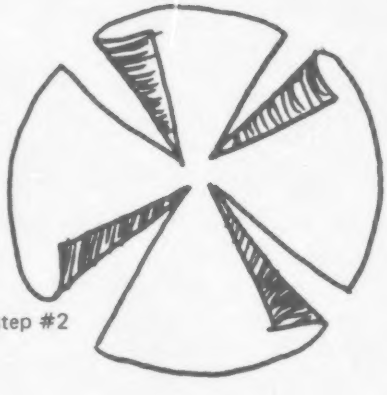
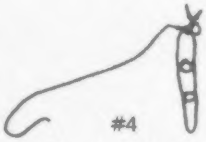
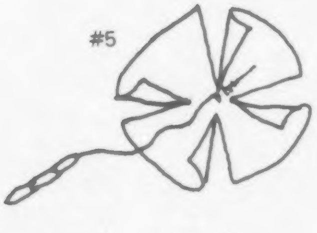
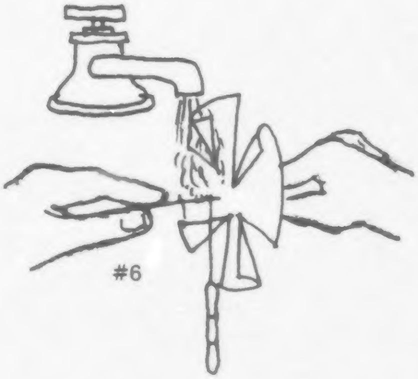

step #1




step #2







Cut the bottom out of a gallon plastic milk container. Fit the top of the container with a one-hole rubber stopper. Place a two inch length of glass tubing in the hole. Connect one end of a two foot piece or rubber tubing. After filling the mild container about 2/3 full of water, hold it upside down. The flow of water can be controlled by pinching the tubing. Direct the stream of water against the pin wheel. The effect of raising and lowering the milk jug on the speed of the pin wheel can also be studied.

Grade Level: 5, 6

Disciplines: Social Studies, Art

Objectives:

The student will be able to identify and locate on maps some of the major coal, oil, and gas-producing areas in the United States and particularly in Pennsylvania.

Suggested Time: 3 class periods

Materials Needed:

Dittoed maps of U.S. and Pennsylvania; maps of coal, oil, and gas-producing areas*; transparencies of these areas if possible; colored pencils or markers

Teacher Notes:

The first oil well of modern times was completed in 1859 in Titusville, Pennsylvania. The grade of crude oil (oil as it comes from the ground, before it is refined and processed) called Pennsylvania crude is still the finest in the world for making lubricants. Unfortunately, reserves of Pennsylvania crude oil are quite small.

Oil and natural gas deposits usually occur together. They are believed to come from animal remains–mainly marine animals–as they accumulated over a long period of time.

Oil reserves are unevenly distributed over the world. The Middle Eastern countries such as Saudi Arabia and Kuwait have about 53% of the reserves. African countries have about 16%. The USSR, Romania, and other eastern European countries have about 15%, while the U.S., including Alaska, has only about 5%. Smaller amounts are found in other countries.

Natural gas is largely methane, which is composed of one carbon atom and four hydrogen atoms. It was first used in the U.S. for lighting in Fredonia, New York. Estimated reserves of natural gas are found in the following areas: U.S.S.R., 30%; U.S., 16%; Iran, 11%; Algeria, 6%; and the remainder in many other countries.

Coal represents over 90% of U.S. fossil fuel reserves, so it is a fuel of major importance. An accident of geology has provided the U.S. with almost a third of the world's coal reserves. The USSR, western Europe, and China have most of the rest of the coal reserves.

Within the U.S., four major areas–Rocky Mountains, Northern Great Plains, Interior, and Eastern–contain more than 90% of the coal reserves. Two of these areas–Northern Great Plains and Rocky Mountains–contain approximately 70% of the coal resources in the U.S., and most of the nation's low sulfur coal. Much of the coal in the Eastern area has a high sulfur content.

Teaching Suggestions:

Introduce the U.S. coal, oil, and natural gas producing areas by using transparency overlays if possible. If transparencies are not available, supply students with maps. Ask students to discuss observations, comparisons, and contrasts concerning the areas, listing the comments on the board.

Examine maps of Pennsylvania coal, oil, and gas reserves. Discuss as above, in particular making comparisons with your local area and the rest of the United States.

Give each student, or each committee of students, ditto maps and maps of fuel-producing areas. Have students design their own color schemes and legends and color in some of the major reserve areas. Perhaps each committee could construct a large oak tag map for display purposes along with samples and/or pictures of coal, oil, and natural gas. Smaller ditto maps could be organized into a booklet dealing with energy.

Each committee could construct a series of questions about the locations of the reserves which could be duplicated and answered by the other committees. The teacher should add significant questions which some students might have overlooked.

Have a class discussion of the resources shown on the maps in light of the energy crisis.

Have a class discussion on why the coal, oil, and gas fields seem to be in rather close proximity.

Discuss how these three fuels might be transported to your area.

Additional Activities:

Have each student cut out the shape of one state and identify the types of fossil fuels found in that state. Display, ranking in some logical order.

Make bar or circle graphs illustrating fuel reserves in several significant states, including Pennsylvania.

Do Activity III-30, page 137 of *Pennsylvania Energy Curriculum for the Middle Grades;* entitled *How Long Might Our Oil and Natural Gas Last?*

*Maps are available from the following sources:

"Coal in Today's World", Natural Coal Association, 1130 17th St., NW., Washington, DC 20036

"History of Natural Gas," American Gas Association, 1515 Wilson Blvd., Arlington, VA 22209

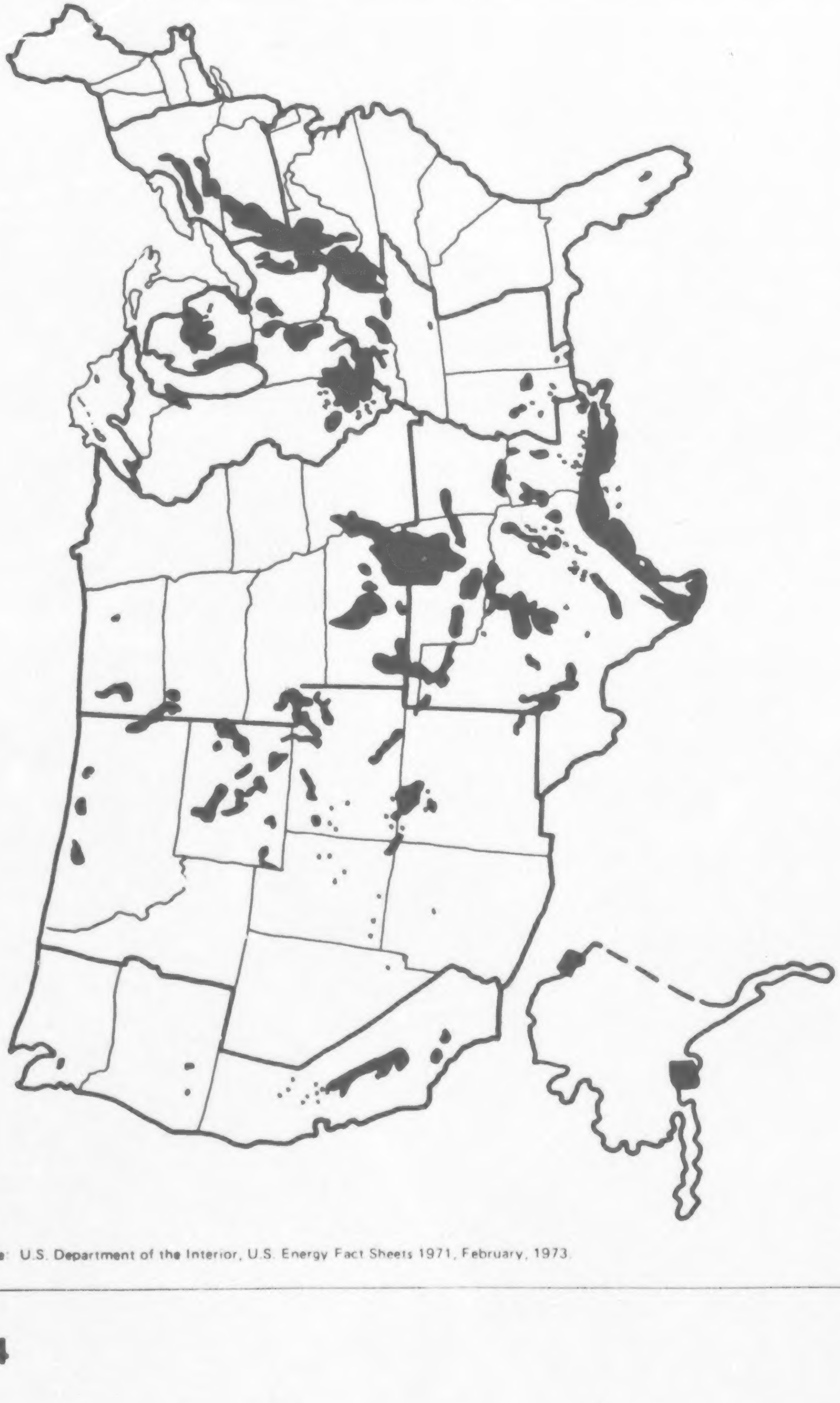
Coal Fields of the U.S., p. 104 of *Pennsylvania Energy Curriculum for the Middle Grades*

Oil and Gas Fields in the U.S., p. 114 of *Pennsylvania Energy Curriculum for the Middle Grades*

The Pennsylvania Energy Primer, Governor's Energy Council, Harrisburg, PA

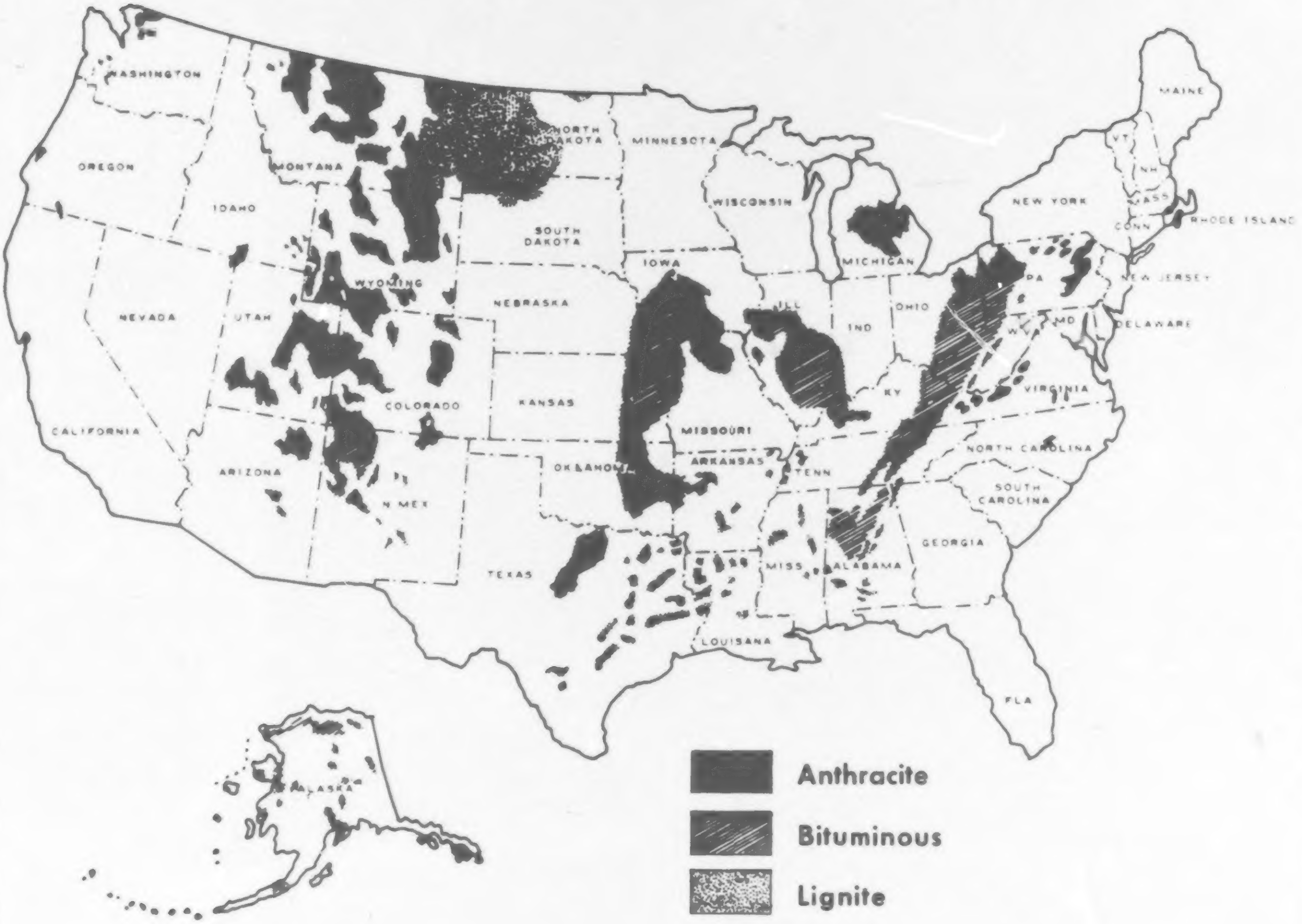
Pennsylvania Energy Curriculum for the Middle Grades, Pennsylvania Department of Education, 333 Market Street, Harrisburg, PA 17126

Oil and Gas Fields in the United States



Source: U.S. Department of the Interior, U.S. Energy Fact Sheets 1971, February, 1973.

COAL FIELDS OF THE UNITED STATES
(FROM UNITED STATES GEOLOGICAL SURVEY)


WASHINGTON
OREGON
CALIFORNIA
NEVADA
IDAHO
MONTANA
WYOMING
UTAH
ARIZONA
COLORADO
N. MEX
NORTH DAKOTA
SOUTH DAKOTA
NEBRASKA
KANSAS
OKLAHOMA
TEXAS
MINNESOTA
IOWA
MISSOURI
ARKANSAS
LOUISANA
WISCONSIN
ILL
MICHIGAN
IND
OHIO
KY
TENN
MISS
ALABAMA
GEORGIA
FLA
SOUTH CAROLINA
NORTH CAROLINA
VIRGINIA
W.V.
MD
DELAWARE
PA
NEW JERSEY
NEW YORK
CONN
RHODE ISLAND
MASS
VT
NH
MAINE
ALASKA
Anthracite
Bituminous
Lignite

Grade Level: 3-6

Disciplines: Science, Language Arts

Objectives:

The student will demonstrate how coal was formed by constructing layers of pressed plants in an aquarium.
The student will be able to describe how coal was formed by writing a paragraph or two on the subject.
The student will be able to identify and describe the characteristics of the four kinds of coal: peat, lignite, bituminous, and anthracite.

Suggested Time: Two to three class periods

Materials Needed:

Ferns, dead plants, mosses, aquarium, peat moss, sand, water, information on coal formation (slides, charts, booklets, encyclopedias, science books), samples of the four kinds of coal (if available), fossil prints.

Teacher Notes:

It is believed by many that millions of years ago, thick forests and swamps covered much of the earth. The climate was hot and damp, even near the North and South Poles. In the forests and swamps there were several kinds of trees, ferns, reeds, and grasses. Because the climate was hot and damp, the plants grew very fast. As they died and fell to the ground, others grew in their places. They soon died and fell, too, and the ground became covered with a thick layer of dead plants. In the swamps this thick layer was covered with water and dirt washed down from higher ground. Then new layers of plants were formed. They, in time, were covered by more water and dirt. The dead plants, water, and dirt were so heavy that the layers underneath became compressed, or packed down. After millions of years, the plants which once had grown in the sunshine lay buried deep in the ground. Then, very slowly the surface of the earth began to change. The sea flowed over the land many times. Under the bottom of the sea, the layers of dead plants were compressed more until they changed into coal. Millions of years later when the sea dried up, new mountains rose and new valleys and plains were formed. The coal lay buried beneath them.

The "Carboniferous Period" is the name scientists have given to that time when the earth was hot and damp and covered with forests and swamps. "Carboniferous" means "coal-bearing," so that period is sometimes called the "Coal Age."

How do we know coal was formed from plants? In today's coal seams and the rocks just above them we find fossils, or impressions, of plants which lived long ago. These fossils are often in the shape of stumps, leaves, seeds, or other parts of plants. Sometimes they show us what whole plants looked like. These fossils tell us something about what the earth was like in the Carboniferous Period.

After the layers of dead plants had been buried thousands of years, they became layers of peat. Peat is brownish-black in color and looks very much like decayed wood. It usually is found in swamps and bogs. When dried, peat will burn and give heat, but it is very smoky.

As time passed, some of the spongy layers of peat were pressed down into thinner layers of lignite. Lignite, a brownish-black coal, gives more heat than peat when it is burned, but is still a very smoky fuel.

Much of the lignite in America was changed long ago by the weight of the earth and ocean into bituminous coal. This coal is harder than lignite, but it is called soft coal because it can be broken easily into the right sizes for its many uses. Bituminous coal is our most abundant kind of coal. Coal which is not quite as hard as bituminous is called subbituminous.

In a few places, the pressure was so great that it changed the coal into anthracite. Anthracite, or hard coal, has a shiny black color and burns with little smoke. There is relatively little anthracite in the U.S., and very little of it is mined now.

The U.S. government says that there are at least one and one half trillion tons of lignite, bituminous coal, and anthracite coal in our country–enough coal to las us more than 300 years. (Adapted from "Coal in Today's World," Education Division, National Coal Association, Washington, DC)

Teaching Suggestions:

Have students examine samples of ferns, peat moss, and types of coal. Ask students to infer what ferns or peat moss might have to do with coal. Ask them to describe the properties of coal that they can observe. Indicate that they are going to simulate the formation of coal.

Using student assistants, fill an aquarium with about an inch layer of dead plants, including some ferns and moss if possible. Cover with about one inch of water. Allow one week to pass. What is the condition of the water? What changes have occurred in the plants? Is there any type of odor? Describe. Suggest reasons for changes and/or no changes.

Sift moderately fine sand over the peat to a depth of one inch. After the sand settles, add an equal depth of plants. Repeat this process for as long as desired, or until several successive layers have formed.

Have students keep a written record of their observations starting with the development of the initial layer.

After the aquarium has several layers constructed, place a flat board upon the top layer and add several books to illustrate the pressing action of tons of ocean water on the layers of vegetation.

If dead plants are not available, peat moss can be used instead. Peat moss is semicarbonized vegetable tissue formed by partial decomposition in water of various plants, especially mosses of the genus Spagnum.

As a follow-up, have students examine diagrams of coal layers found in encyclopedia articles on coal or in other pamphlets. Ask students to write a short paragraph or two describing how coal was formed. They can illustrate them with layer diagrams.

If possible, have students examine the four types of coal and describe how each is different from the others. Classify according to smokiness, color, and hardness. You might construct a matching game with porperties written on 3 x 5 cards.

Additional Activities:

Construct bulletin boards, booklets, etc., illustrating coal layers and coal types.

Have committees construct coal layers using strips of colored paper, clay, sand, dirt, or charcoal layers in jars or other containers.

Adapted from an activity developed by Michelle Alexander and John Neth, Groveport-Madison High School, Groveport, Ohio

Grade Level: 3-5

Disciplines: Social Studies, Language Arts

Objectives:

The student will be able to identify the three main fossil fuels and describe their properties and uses.
The student will be able to give a simple explanation of how the three main fossil fuels were formed.

Suggested Time: 2-3 class periods

Materials Needed:

Samples of fossil fuels, samples of fossils, movies, filmstrips, or transparencies on fossil fuels if available, encyclopedias, science books, booklets *The History of Natural Gas** and *Mickey Mouse and Goofy Explore Energy**

Teacher Notes:

The fossil fuels we rely on today were formed from the remains of plants and tiny marine animals that lived millions of years ago. These fossil fuels are oil, natural gas, and coal.

Oil is trapped in porous rock beneath the surface of the earth. To find it, we must often drill thousands of feet. Drilling rigs can be set up on land or in the ocean, wherever oil can be found. Taking oil from where it is discovered requires a great deal of human and machine energy. At the present time we do not produce enough oil in our country to fill our energy needs, so we must import about half of our oil from foreign sources.

Every day we use products made from oil. Some of it is used for heating; some is used as gasoline and motor oil for transportation purposes. Kerosene for jet aircraft, diesel fuel for trucks and machinery, and asphalt for our roads all come from petroleum. Oil is also used as a raw material to make new products and conveniences. The plastics industry uses petroleum to manufacture packaging, furniture, and toys. Synthetic fabrics, such as nylon, have been developed from petroleum. Even some medicines are derived from petroleum, as are many chemicals and fertilizers.

Natural gas is the cleanest burning of the fossil fuels. It is usually the most convenient fuel to produce and use. Natural gas is trapped in layers of rock, and frequently found with oil deposits. The U.S. still has untapped reserves of natural gas, but the methods of recovering some of it are expensive.

Coal is the most abundant fossil fuel in the U.S. It is used to generate electricty and in industries such as steel. Two methods of mining are used: strip or surface mining and deep or underground mining. Surface mining, used when the coal lies close to the surface of the earth, is done by giant shovels that strip away the earth on top of the coal seam, and then scoop the coal from the earth. Underground mines are tunneled beneath the surface of the earth to reach the coal. Our oldest major deep mining area stretches along the Appalachian Mountains from Pennsylvania to Alabama. Most of the mining in the West is surface mining.

Teaching Suggestions:

Display samples of coal and oil. Ask, "What are these? What are some of their properties? Where are they found? How do we get them out of the ground? What are they used for? Why are they called fossil fields? What is another fossil fuel?"

If possible, light a small sample of the oil with a match, heat a piece of coal with a burner, and/or demonstrate a bunsen burner or gas burner in the cafeteria.

Ask, "How were these three fossil fuels made?" Choose from any or all of the following to investigate their origin.

1. Show movies, filmstrips, and/or transparencies, if available.
2. Assign teams to do research in encyclopedias, science books, or pamphlets. Encourage drawings with captions and simple presentation of findings. Summarize important points.

3. Obtain free copies of "The History of Natural Gas," a comic-book format presentation. Assign reading parts to various students and have them read orally, like a play. At the conclusion, discuss briefly and list the important points. Perhaps students could make an illustrated timeline of the significant events with each student contributing a captioned drawing.

4. Obtain free copies of "Micky Mouse and Goofy Explore Energy," a comic-book format. Use as in #3 above.

5. Show samples of fossils, especiall fossil prints of plants and shells, if available.

*"The History of Natural Gas," available from Educational Services, American Gas Association, 1515 Wilson Blvd., Arlington, VA 22201.

*"Micky Mouse and Goofy Explore Energy," available from Walt Disney Educational Media Company, 500 South Buena Vista St., Burbank, CA 91521

Grade Level: 4-6

Disciplines: Social Studies, Language Arts

Objectives:

The students will define primary sources of energy and identify six such sources.
The students will identify several uses of each of the six primary energy sources.
The student will explain why electricity is not a primary energy source.

Suggested Time: One or two class periods

Materials Needed:

Samples and/or pictures of primary energy sources (wood, oil, natural gas, falling water, coal, and uranium), two activity sheets that follow

Teacher Notes:

Throughout human history, people have relied on an increasing number of energy resources to work for them. Originally people relied only on their own muscle power, and later on that of animals, to do their work. Then they sought to expand their energy resources by using the energy in wood, water, and the wind. In the 18th century, people began to use the energy of coal, the first fossil fuel to be discovered. Later came the use of oil and natural gas. In this century, we have begun to tap nuclear energy. We are also looking closely at other energy sources–such as solar, geothermal, and coal gasification–in an attempt to provide sufficient energy while living compatably with our environment.

Primary sources of energy are those materials from which energy can be directly released and used immediately. They are naturally available for use on the earth. They include the fossil fuels (coal, peat, oil, oil shale, natural gas, and tar sands), non-fossil fuels (uranium, hydrogen), solar energy in its various forms (radiant energy, wind, wood), geothermal energy, and falling water (hydropower). All fossil fuels and nuclear fuels are Non-renewable: once they are used, they are gone. Solar, falling water, wood, wind, and geothermal energy are renewable sources of energy.

The primary sources of energy are used to heat our buildings, move vehicles, run factories, and generate electric power. Moreover, they are important in the manufacture of many materials such as dyes, medicines, detergents, plastics, and coke for the steel industry.

Electricity is a secondary energy source, since some primary source must be used to produce it.

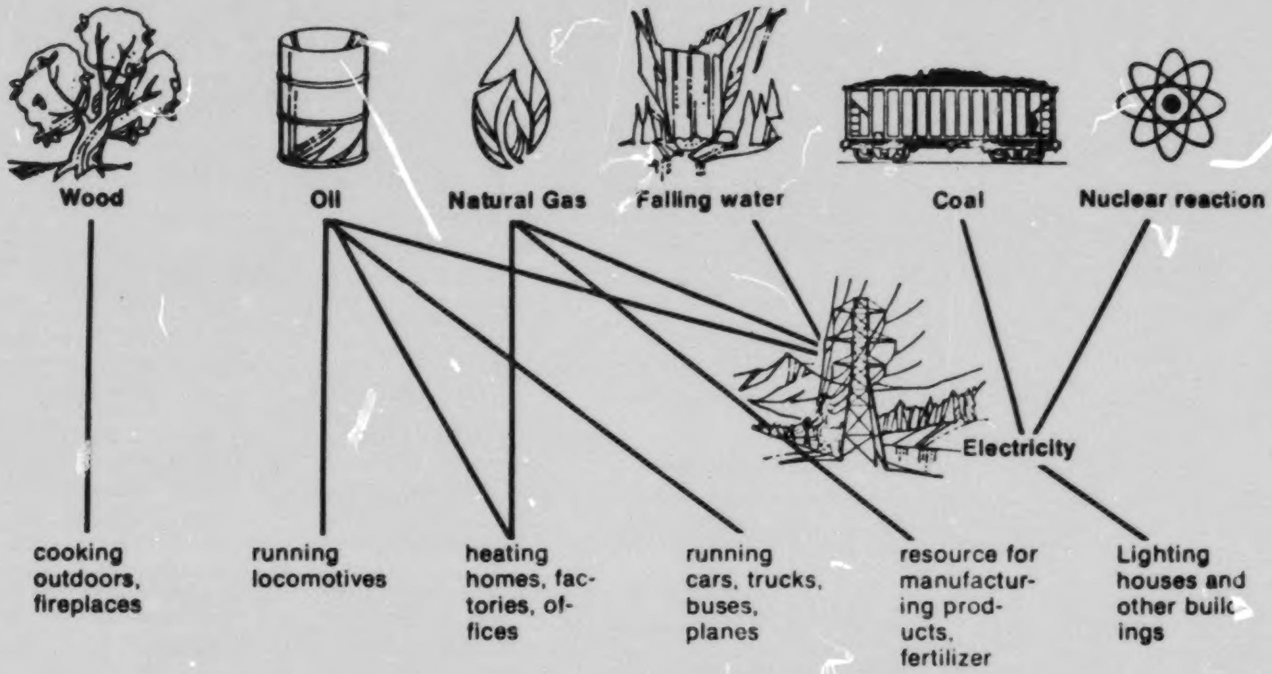
Teaching Suggestions:

Display samples or pictures of wood, oil, natural gas, falling water, coal, and uranium. Ask: "Where did these come from? What connection might they have with energy? How could we get energy from these immediately? Since we can get energy directly from these, what kind of energy sources might we call them? (You might need to supply the word "primary". Using student suggestions, make a list on the board of some uses of each of these primary energy sources.

Duplicate for each student a copy of "Primary Energy Sources," or make a transparency. Discuss the connections between the primary energy sources and their uses. Try to have students discover why electricity is not a primary source, but rather a secondary source of energy. Discuss the questions under the diagram.

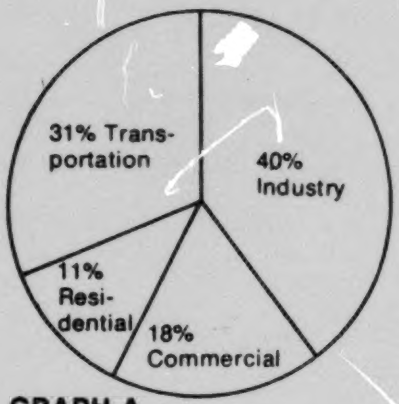
Duplicate copies of "Where we get our Energy, How we Use it." Have students complete and discuss. A completed sheet is included.

Primary Energy Sources


Wood
Oil
Natural Gas
Falling water
Coal
Nuclear reaction
Electricity
cooking outdoors, fireplaces
running locomotives
heating homes, factories, offices
running cars, trucks, buses, planes
resource for manufacturing products, fertilizer
Lighting houses and other buildings

The diagram above shows six primary sources of energy. Lines connect each primary energy source to the most important work it does. Which energy source is seldom used today? Which two do not involve burning to produce power? Which ones are used to make electricity?

Where We Get Our Energy
How We Use It



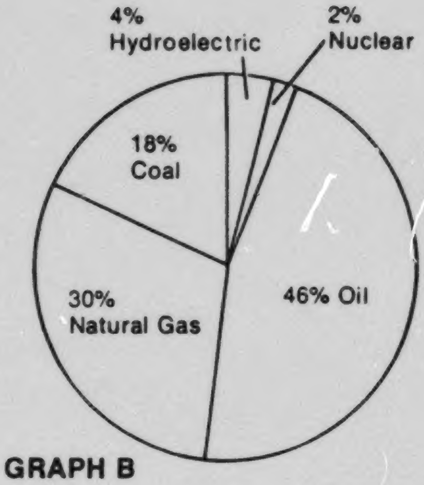
GRAPH A

Graph A divides our energy use into four groups. In what group do we use the most energy? ______________________. What ranks second? ______________________. In what ways do you use energy in each of these two groups? What group(s) gives you the most opportunity to cut down on your energy consumption?

Which groups use energy when you do each of the following. Check the box or boxes in the appropriate columns.

(The first one is done for you.)

	Industry	Transportation	Commercial	Residential
1. Take a hot bath				✓
2. Drive to a hamburger stand				
3. Fly in an airplane				
4. Switch on air-conditioning				
5. Buy a new baseball				
6. Ride a school bus				
7. Blow dry your hair at home				
8. Buy a frozen pizza				
9. Ride a motor-bike				
10. Manufacture a motor-bike				



GRAPH B

Graph B shows five primary sources of energy. These five sources supply Americans with most of their energy needs. They light and heat the buildings in which we live, work, and play. They fuel our vehicles. They run the machines that work for us and manufacture and process the goods we use and the foods we eat. Look at Graph B and answer these questions.

1. What energy source do we use most?

______________________.

2. Which do we use mostly for heating our homes?

______________________.

3. What energy source provides most of the fuel for our transportation?

______________________.

4. Which one makes most of our electricity?

______________________.

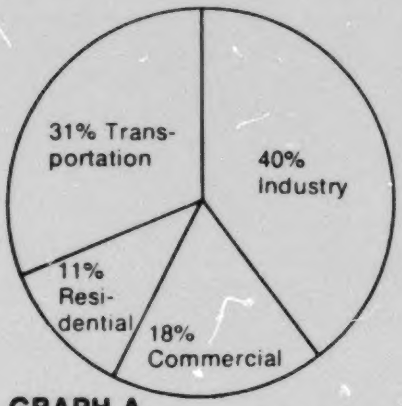
5. What is a possible reason why we use so little hydroelectric energy?

____

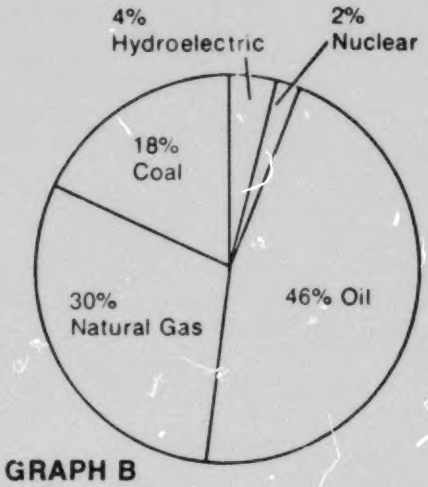
6. Why is electricity not shown on this chart?

______________________.

Where We Get Our Energy
How We Use It



GRAPH A



GRAPH B

Graph A divides our energy use into four groups. In what group do we use the most energy? industry
What ranks second? transportation
In what ways do you use energy in each of these two groups? What group(s) gives you the most opportunity to cut down on your energy consumption?

Which groups use energy when you do each of the following. Check the box or boxes in the appropriate columns.

(The first one is done for you.)

Every item that includes a product could also be checked under "Industry."

	Industry	Transportation	Commercial	Residential
1. Take a hot bath				✓
2. Drive to a hamburger stand		✓	(✓)	
3. Fly in an airplane		✓		
4. Switch on air-conditioning	✓			✓
5. Buy a new baseball			✓	
6. Ride a school bus		✓		
7. Blow dry your hair at home				✓
8. Buy a frozen pizza			✓	
9. Ride a motor-bike		✓		
10. Manufacture a motor-bike	✓			

Graph B shows five primary sources of energy. These five sources supply Americans with most of their energy needs. They light and heat the buildings in which we live, work, and play. They fuel our vehicles. They run the machines that work for us and manufacture and process the goods we use and the foods we eat. Look at Graph B and answer these questions.

1. What energy source do we use most?
oil

2. Which do we use mostly for heating our homes?
natural gas

3. What energy source provides most of the fuel for our transportation?
oil

4. Which one makes most of our electricity?
coal

5. What is a possible reason why we use so little hydroelectric energy?
not very much falling water

6. Why is electricity not shown on this chart?
it is a secondary source

Grade Level: 6

Disciplines: Social Studies, Language Arts

Objectives:

The students will research and report on the formation, extraction, transportation, and use of the three major fossil fuels.

Suggested Time: Two to three weeks

Materials Needed:

Encyclopedias, science books, pamphlets, and periodicals

Teacher Suggestions:

Divide the class into three groups. Have each group research one of the three fossil fuels–coal, natural gas, or oil. The students within each group might divid their topic into sections and have each student research one section. Have students report on their research, making up a booklet from the various groups and/or reporting orally to the class. Encourage charts, pictures, and other illustrations.

Other Activities:

Build oil derricks with straws and/or toothpicks.
Collect and display pictures relating to the three fossil fuels.
Visit a highway cut to observe layers of various deposits in order to discuss how fossils and fossil fuels were formed.
Prepare reports which tell advantages and disadvantages of each of the fossil fuels.
Invite resource people to visit with your class. Make a display of products made from fossil fuels.

VII.

Electrical Energy

Grade Level: 3-6

Discipline: Science

Objective:

The student will demonstrate the production and effects of static electricity using different types of non-conducting substances.

Suggested Time: One class period

Materials Needed:

Comb, wool, silk, hard rubber, glass rod, tissue paper, balloon, sheet of glass, pieces of paper, two books.

Teacher Notes:

For a discussion of static electricity, see page 44 of *Pennsylvania's Energy Curriculum for the Middle Grades*, available from the Pennsylvania Department of Education.

Atmospheric conditions are very important in successfully demonstrating static electricity. It works best on a day with low humidity. On a humid day, the water vapor in the air will enable the charge to leak away rapidly, returning the objects to a neutral charge.

In these demonstrations, the following will occur: The comb will attract electrons from the hair and wool, giving the comb an excess of electrons or overall negative charge, and leaving the hair and wool with fewer electrons or overall positive charge. The silk will become positively charged when rubbed on the piece of hard rubber, and negatively charged when rubbed on the glass rod. Note that a substance does not always have the same charge. The silk becomes positive in the first instance and negative in the second instance. It depends on the nature of the two materials which are rubbed together. In the other two activities, the baloon will stick to the wall and the pieces of paper will jump about due to static electricity.

Teaching Suggestions:

Demonstrate static electricty by:

having students comb their hair or rub a plastic comb on a wool sleeve
having student rub a piece of silk with any sort of hard rubber
    material
having students rub a piece of silk with a glass rod
having students hold tissue paper against the blackboard and rub
    it rapidly with a silk cloth
rubbing a filled baloon in student's hair and observing the results
    when the baloon is placed against the wall. This will work
    only when hair is clean and dry, not oily.
using a piece of glass, two books, and some scraps of paper and
    a silk cloth. Lay the two books on the table about 4 inches apart. Place pieces of paper underneath a sheet of glass resting on the two books. Rub the glass with the silk cloth. Watch what happens. Do this in the dark if possible.

Grade Level: 5, 6

Discipline: Science

Objective:

The student will produce and detect an electric current from a simple wet cell using readily available materials.

Suggested Time: One class period

Materials Needed:

Lemon, knife, copper strip (or copper penny), zinc strip (from old dry cell or zinc coated washer), galvanometer (commercially made or home-made-instructions follow), piece of connecting wire, copper strip.

Teaching Suggestions:

This experiment will demonstrate how to create electricity from a lemon. First, roll a lemon on the table, pushing on it with you hand to break up some of the tissue inside. Cut two slits an inch in length in the skin of the lemon. Push the strips of zinc and copper into the slits, making sure they do not touch. Connect a wire from the copper strip to the terminal of a galvanometer and a wire from the zinc strip to the other terminal. Watch the meter. Describe what happens and why. For best results, it will be necessary for you to clean the metal strips with steel wool or fine sand paper. Make sure that there are no loose connections.

If a commercially made galvanometer is not available, you can make one as follows: get a boy scout compass and a 4-foot piece of thin insulated wire. Wrap the insulated wire around the N-S axis of the compass, leaving the ends of the wire stripped of the insulation for an electrical attchment. Connect the lemon wet cell or a dry cell to the coil and observe the compass needle. Current passing through the wire should cause the needle, which had been pointing north, to shift toward the E-W direction. current passing through the wire creates a magnetic field stronger than the earth's magnetic field, and the needle shifts. A more sensitive galvanometer can be made by building a little wooden frame just large enough to hold the compass. Place the compass in the tightly fitted frame and then wind about 20 turns of bell wire over the frame, making sure to orient the compass so that the needle pointing toward the north is hidden by the wire. Connect as before.

In general, an electric current can be produced from any two different metals immersed in an electrolyte. The amount of current flow or voltage is determined primarily by the choice of metals used in producing the current.

Grade Level: 4-6

Discipline: Science

Objective:

The student will build a generator consisting of a bar magnet and a coil of bell wire, and use it to demonstrate the production of electricity.

Materials Needed:

Mailing tube, copper bell wire, bar magnet

Teacher Suggestions:

Wind about 50 to 100 turns of wire around the hollow tube. Connect the ends of this wire to the two posts of a galvanometer. Push the bar magnet completely through the hollow tube and observe the galvanometer. Reverse the direction of the magnet through the tube and observe again. Also try moving the magnet back and forth rapidly within the tube and observe the meter. In this demonstration, as the magnet is moved in and out of the coil, magnetic lines of force are broken and a current is set up in the coil. This can be observed on the galvanometer.

Grade Level: 5, 6

Discipline: Science

Objective:

The student will build and demonstrate an electromagnet

Suggested Time: 2 class periods

Materials Needed:

2 inch bolt with nut (or nail if bolt is not available) 2 washers, roll of insulated bell wire, two dry cells or one large dry cell, small objects, both metal and non-metal

Teacher Notes:

A bar of iron placed in a coil through which a current is flowing becomes magnetized. In this way, it is possible to make electromagnets, which are extremely useful in converting electrical energy into mechanical energy, being a major component of electric motors It will become evident that an electromagnet loses its magnetism quickly after the circuit has been disconnected. Only objects containing iron and steel will be picked up by the electromagnet.

Teaching Suggestions:

Place a washer at each end of the bolt and screw the nut just on to the bolt. If a bolt is not available, a large steel nail can be used without the washers. Wind layers of insulated bell wire on the bolt between the washers, making certain to leave one foot of wire sticking out when you start winding the coil. When you have filled the bolt between the washers with several layers of turns of wire, cut the wire, again leaving about one foot of wire. To keep the wire from unwinding from the bolt, some taping can be done. Connect the two ends of wire to two dry cells in series, or to a larger dry cell. (To connect in series means to connect the negative terminal of one battery with a short wire to the positive terminal of the other.) Attach the electromagnet to the dry cells. Pick up some tacks or small nails or paper clips. Disconnect one wire from the battery while the tacks are still attached. What happens? Using the electromagnet, pick up other objects made of iron or steel. Try brass, nickel, copper, and non-metallic materials. Explain the results.

Other Activities:

Examine and operate some devices using electromagnets: buzzers, bells, electric motors, telephone, telegraph, generators.

Obtain some pictures of huge electromagnets used in scrapyards and recycling plants.

Experiment with different numbers of dry cells connected in series and/or varying the number of coils in an electromagnet. Record the number of tacks or clips picked up with each variation.

Put an electromagnet under a glass and pour iron filings onto the glass. Observe the magnetic lines of force. This experiment works very well on the top of an overhead projector.

Make miniature electromagnets with large needles as the core.

Research and discuss how electrical energy in electromagnets is converted to mechanical energy and often sound energy, as in buzzers.

Build a simple electric motor or telegraph, noting the use of the electromagnet.

Grade Level: 5, 6

Disciplines: Science, Social Studies

Objectives:

The student will identify primary sources of energy that can be converted to electrical energy.
The student will identify other forms of energy that can be produced from electrical energy.

Suggeste Time and Materials Needed: Depends on options chosen

Teacher Notes:

The electricity that we use is generated from fossil fuels, nuclear energy, and hydroelectric plants. Electricity can also be generated by other sources: wind energy, chemical energy, geothermal energy, solar energy, and mechanical energy.

Electrical energy can in turn be converted into several other types of energy: sound energy (door bell), heat energy (electric stove), light energy (electric lights), mechanical energy (electric motor), and chemical energy (Charging a battery).

Teaching Suggestions:

Demonstrate or illustrate methods of generating electricity:

If a hand generator is available, use bell wire to connect both terminals of the generator to both terminals of a light socket. You might also invert a bicycle with a generator attached and move the bicycle wheels to light the bulb. This illustrates electrical energy produced from mechanical energy.

Connect a dry cell to a small light socket (or turn on a flashlight). This illustrates electrical energy and light and heat energy produced from chemical energy.

Use visual aids to illustrate how electrical energy can be produced from wind power, hydroelectric power, nuclear power, geothermal energy, and solar energy.

Demonstrate or illustrate methods of turning electricity into other forms of energy:

Connect a buzzer or bell or telegraph to a dry cell. Note that chemical energy is converted to electrical energy which is converted to mechanical energy which is converted to sound energy.

Connect a hot plate to an electrical socket. Electrical energy is converted to heat energy and a certain amount of light energy. If a large light bulb is connected to a socket, there will be a considerable degree of both heat and light energy produced by electrical energy.

Flip on the lights in the room to illustrate electrical energy being converted to light energy.

Connect an electric motor (or an electric clock, which contains a motor) to a socket to observe how electrical energy is converted to mechanical energy, with a certain amount of heat energy (feel motor) and sound energy (listen to hum).

Turn on a radio and discuss the various forms of conversion of energy that occur beginning with the sound initially created at the radio station. Do the same with a TV set. Trace the energy flow on the blackboard.

Grade Level: 5, 6

Discipline: Social Studies

Objective:

The student will investigate the major sources of electrical energy today.

Materials Needed:

Encyclopedias, pamphlets, science books, and periodicals for research.

Teacher Notes:

In light of the growing energy crisis, students need to be aware of the fact that the fossil fuels (coal, oil, and natural gas) are the major primary sources of electricity today, with a smaller percentage being generated by nuclear power.

Teacher Suggestions:

Have students do research into the present-day methods of generating electrical energy. Reports can be illustrated with simple diagrams.

If possible, visit an electric power plant or have a representative visit your class.

Grade Level: 4-6

Discipline: Science

Objective:

The student will observe the use of steam to turn a pinwheel, and relate this to the generation of electricity.

Suggested Time: One to two class periods

Materials Needed:

100 ml water, 250 ml pyrex flask, one-hole rubber stopper, glass tubing, rubber tubing (1/2 meter), medicine dropper, pinwheel, bunsen burner or hotplate, galvanometer and small powerful magnet if available

Teacher Suggestions:

Put about 100 ml of water into a 250 ml pyrex flask. Fit the flask with a one-hole stopper, put a piece of glass tubing in the stopper, and connect a piece of rubber hose to the glass tube. Attach the glass portion of a medicine dropper to the other end in such a way as to enable the dropper end to be exposed. Heat the water in the flask to boiling. CAUTION: Do not heat the flask too rapidly. If you produce steam faster than it can escape through the tube, something will give. Be sure to add boiling chips to the water. When enough steam has been generated through the tip of the hose mechanism, position the dropper in such a way as to spin the pinwheel. Insulate the part of the rubber tube you are holding with a paper towel. The spinning of the pinwheel simulates the action of turbines used to generate electricity.

It may be possible to attach some type of short rod to the axle of the pinwheel with a small powerful magnet attached to the rod which would be allowed to rotate inside a coil of wire attached to a galvanometer. This would illustrate the production of an electric current.

If possible, try to follow up with pictures of the inside of a power plant that uses some sort of fuel to produce steam to generate electricity.

Grade Level: 3-6

Discipline: Science

Objective:

The student will observe a demonstration of the use of moving water to generate electricity.

Suggested Time: One to two class periods

Materials Needed:

Garden hose, homemade water wheel (or perhaps a small premade one used in some aquariums or miniature garden pools), small powerful magnet attached to a rod which is in turn attached to the axle of the water wheel, coil of bell wire, galvanometer

Teaching Suggestions:

Run a moderately strong stream of water over the water wheel in such a way that the attached magnet rotates in a coil of wire attached to a galvanometer. A water faucet might be used in place of a hose.

Grade Level: 5, 6

Discipline: Science

Objectives:

The student should be able to make a circuit with wires, dry cells, and bulbs, recognize open and closed circuits, and arrange bulbs in series and parallel circuits and distinguish between the two.

Suggested Time: One to three class periods

Materials Needed:

Dry cells (size d), bell wire (uninsulated), flashlight bulbs, switches, sockets for bulbs

Teacher Notes:

An electrical circuit is an arrangement of components which provides a path around which electrical charges can flow. When this flow takes place, we speak of a closed circuit. When an air gap or some other non-conducting segment prevents the flow, it becomes an open circuit. (A short circuit is a path through which potentially large currents can flow.)

The simplest electrical circuit consits of a source (in this case, a battery), the conducting wires which link the various components together, and a conversion device, such as a bell, light, heating element, etc.

The idea of a circuit emphasizes that electricity is a flow of electrical charges that must be continuous from source through conversion back to source. Electrons, in simple circuits such as the one we look at first, leave the battery with some kinetic energy, flow through the wires (losing some kinetic energy in heating up the wires), give up most of their kinetic energy in the form of light and heat in the light bulb and finally return, with very little energy lost, to the battery. Energy has been converted, but the same number of electrons that leave the battery re-enter it each second.

Electrical devices (bulbs, dry cells) may be connected in two basic connections: series or parallel. In a series connection, each bulb must be working in order for the others to work. In a parallel connection, the electricity is divided and flows through each bulb. Each bulb, therefore, is part of a separate circuit, independent of the other bulbs.

Teaching Suggestions:

Ask the class to list as many ways possible in which they use electricity. Write the list on the board.

Ask students to describe where the electricity comes from and how it gets to each of these examples.

Then distribute the materials for making a model of an electrical system: flashlight bulb, wire (uninsulated, or at least bare at both ends), flashlight battery or dry cell. Wind one

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end of bare wire tightly around the threaded part of the flashlight bulb. Tape the other end to the metal contact at the bottom of the bulb. Then give students the wired bulb and battery and ask them to make the bulb light up. They should recognize that both wires have to be connected separately to the top and bottom terminals of the battery. Discuss the concept of a circuit, tracing the path of the electrical current out of the battery, through the bulb, and back into the battery. (If you have a burned out bulb available, you might give it to a student to see if he/she can discover that the filament inside the bulb is broken, making the path through the bulb incomplete. Be sure to use a bulb in which the broken filament is visible.

Let the students experiment with the electrical systems:

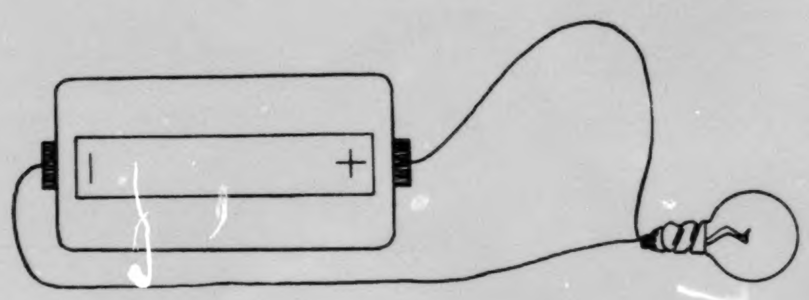
by seeing if it makes any difference which wire is connected to the positive end of the battery and which to the negative end.

by adding two pieces of wire

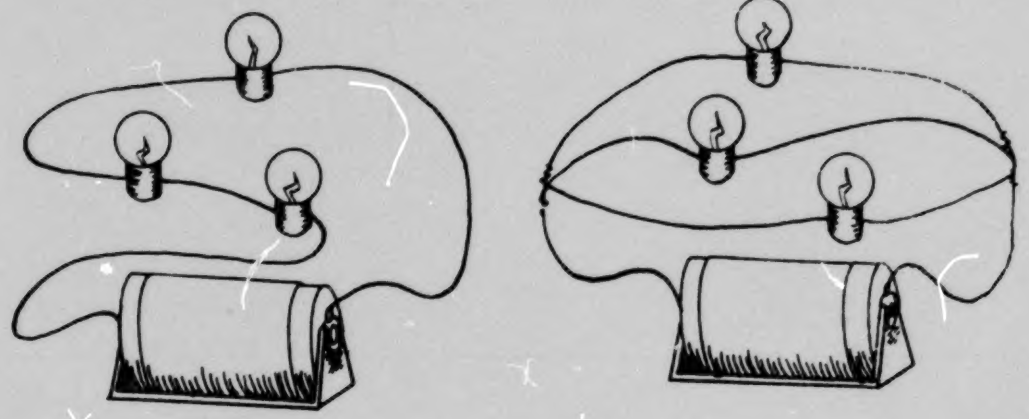
by adding pieces of string. Why doesn't it work with string?

by seeing if they can connect additional batteries or bulbs to the system. The difference between an open and closed circut can be illustrated by adding switch to the circuit. An old fashioned switch with a metal strip that moves in and out of the circuit is best. The switch controls the electric flow. Ask: "How can you tell when you have a closed circuit?" (Bulbs light) "What shows that you have an open circuit?" (Bulbs do not light.)

Ask: "What kinds of things do you need for an electric circuit?" Lead them to the idea of a source, an energy conversion device, like the bulb, and the connecting wire. Help them to find out that each of these has a different use by experimenting, trying to build a working circuit without one of the three components (two batteries and no bulbs, for instance). "Can you make a complete circuit without the bulb? How would you know if it is complete?" (The wire gets hot, so electricity must be flowing through it.) Note: Be careful. The wire gets very hot! The students should be able to generlalize that without the bulb the wire is both a conductor and the Energy-converting device. You always need all three types of components to make a complete circuit.



Choose students to make up two teams. Have two or three students per team. Give each team three bulbs, lengths of wire, and batteries. Have one team connect these components in a series circuit. The other team should connect the bulbs in a parallel circuit as shown in the diagram. Have the students disconnect one of the bulbs from the series set. "What happens?" (All the bulbs go out.) Have the students disconnect a bulb from the parallel set. "What happens?" (The other bulbs do not go out.)



Grade Level: 4-6

Discipline: Science

Objective:

The students will simulate the generation and distribution system of a city.

Suggested Time: One class period

Materials Needed:

Hand crank generator, flashlight bulbs, sockets for bulbs, five pieces of insulated wire (lengths of six feet each)

Teacher Suggestions:

Choose five or six students from the class to represent some parts of a city. Have the students stand in different parts of the room. Have one student represent the power plant, and turn the generator. Have the other students place their bulbs in a socket and connect their socket with wire to the next student's socket. In this way they will make a series circuit. Connect the circuit to the generator. If all components are working, the *city* should light up.

Dry cells may be used instead of a hand-cranked generator.

Ask the following questions: "What does the generator do?" (It produces the current in the wire which lights the bulbs). "What would happen to different parts of the 'city' if the generator did not do its job?" (Have students disconnect one of the wires leading from the generator.)

Tell the students that they now have to supply the city with electricity, but without using wires you can see. What suggestions do they have?

Grade Level: 4-6

Discipline: Science

Objective:

The students will make an electric quiz board.

Suggested Time: Two or three class periods

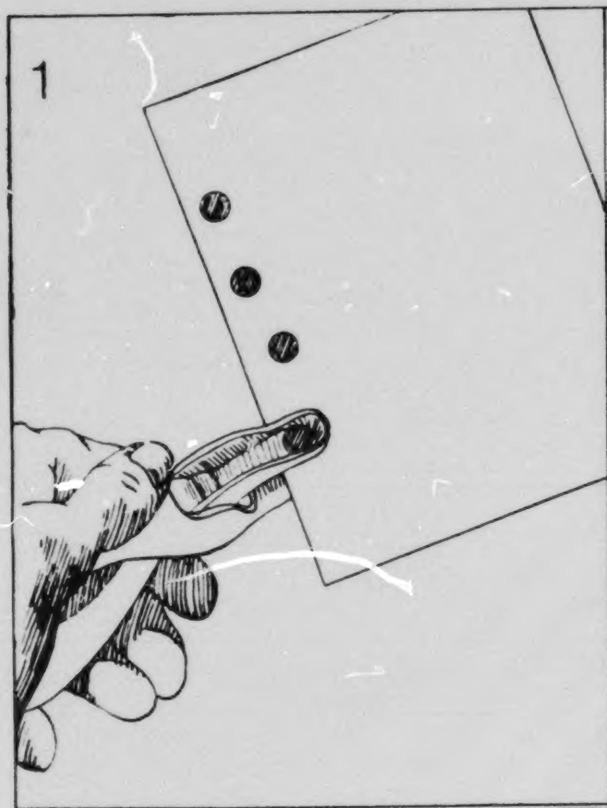
Materials Needed:

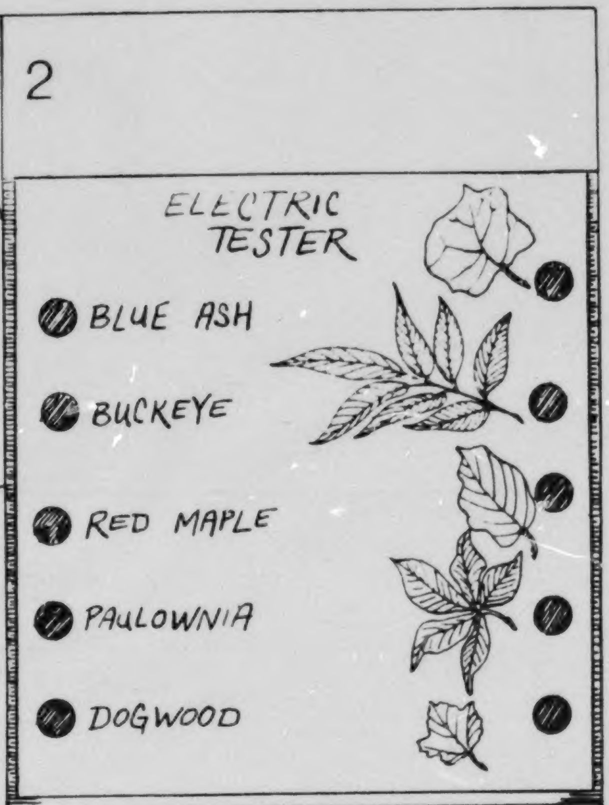
Tape, hole puncher, aluminum foil strips, thin cardboard, paper fasteners, paper, light circuit (see diagram)

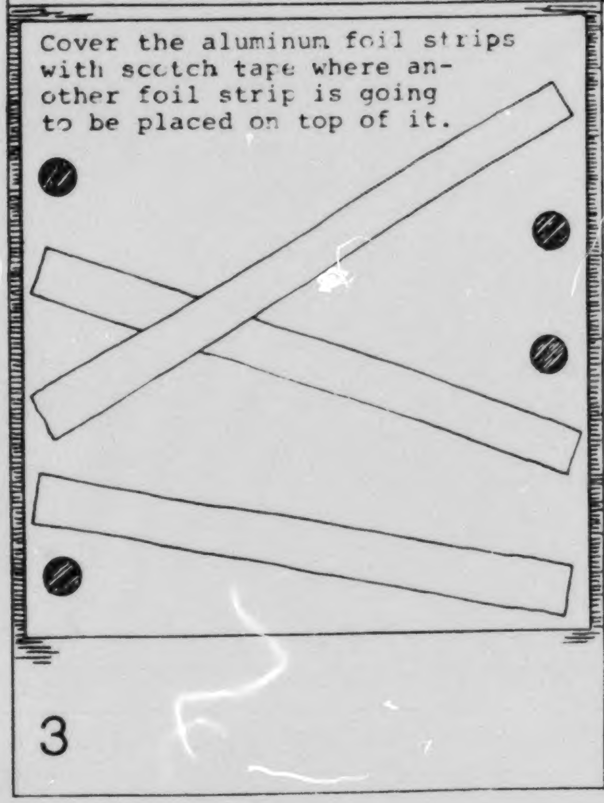
Teacher Suggestions:

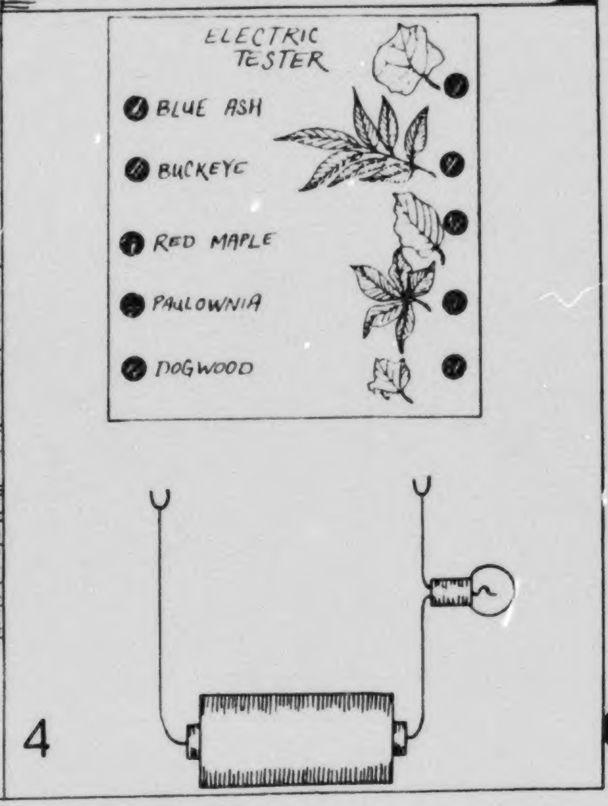
It is suggested that this be a small group activity. The students can design the electric quiz board on any subject, using questions or pictures.

Punch two rows of holes in a sheet of thin cardboard. Put questions or pictures next to one row of holes. Write the names or answers next to the other, but do not put them in the same order. On the back of the thin cardboard, connect the holes that match. Use strips of aluminum foil for the connections. Use a light circuit with an opening in it. Use this circuit to check each part of the test. The light should go on when you hold the wires in any two holes that match. If the answer is right, the light will come on.




2
ELECTRIC TESTER
BLUE ASH
BUCKEYE
RED MAPLE
PAULOWNIA
DOGWOOD


Cover the aluminum foil strips with scotch tape where another foil strip is going to be placed on top of it.


4
ELECTRIC TESTER
BLUE ASH
BUCKEYE
RED MAPLE
PAULOWNIA
DOGWOOD

Grade Level: 6

Discipline: Science

Objective:

The student will investigate the energy consumption of household appliances.

Suggested Time: One class period

Materials Needed:

Activity Master "Electricity, Our Most Amazing Servant" that follows

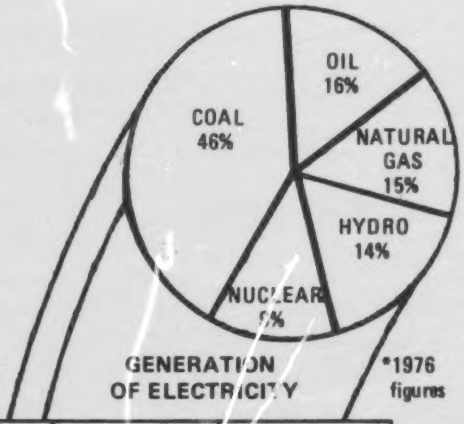
Teacher Notes:

Use the following activity

ELECTRICITY, OUR MOST AMAZING SERVANT

About 25 percent of the U.S. fuel budget goes into the generation of electricity. Electricity is called a secondary, or intermediate form of energy. It must be created by moving water (dams or waterfalls); or by burning fossil fuels or nuclear reaction to create steam in a generator. Electric current is formed that moves along transmission wires to where we can use it. Electricity is not a very efficient form of energy; about 2/3 of the potential energy is lost from source to user.

To see how the use of electicity has increased over two generations (50 years), check the appliances below that your family uses now; then check which you think your parents used when they were children; and which your grandparents used when they were children. (Use of electricity is measured in kilowatt hours: the number of watts marked on the appliance x no. of hours used each month ÷ 1000).



GENERATION OF ELECTRICITY

*1976 figures

ITEM	avg. kwh per mo.*	your family	parents	grandparents
Dishwater	35			
Microwave Oven	16			
Electric Range	98			
Blender	1			
Can Opener	1			
Electric Clock	1			
Automatic Coffeemaker	8			
Toaster	3			
Slow Cooker	12			
Refrigerator	152			
Vacuum Cleaner	4			
Clothes Washer	9			
Clothes Dryer	80			
Space Heater	75			
Water Heater	400			
Color TV	55			
B & W TV	30			
Radio-Record Player	9			
Power Saw	4			
Electric Blanket	12			
Hair Dryer	10			
Electric Toothbrush	1			
Room Air Conditioner	72			
Electric Fan	12			
Electric Furnace	1100			
Yard Light	30			
Garage Door Opener	1			

If you had lived in the year 1900, you would have used only one-fourth of the energy you use today. In the year 2000, you will use almost twice as much as you use today if demand continues at the present rate. What will happen is demand increases?

*TVA Power and Edison Electric

Grade Level: 4-6

Discipline: Science, Social Studies

Objective:

The student will investigate the need for electricity.

Suggested Time: One class period

Materials Needed:

Activity Master "Electricity: Who Needs It?" that follows

Teacher Notes:

Use the following activity

ELECTRICITY: WHO NEEDS IT?

MATH
BUS STOP

Imagine a day that starts something like this. You roll over in your bed, open your eyes, and discover that the morning seems much brighter than it usually does at the start of your day. You check your alarm clock, but that turns out to be no help at all. It is stopped at 12:05. You know that's not right! You jump out of bed and bound into the kitchen. The battery-operated clock on the wall tells you that you have only 15 minutes to get to school-just enough time for a quick slice of toast and a cup of hot instant chocolate.

Before you go back to your room to get dressed, you pop a slice of bread into the toaster and turn on the elctric range to boil some water. When you get back to the kitchen, you find that everything is exactly the way you left it-the bread is untoasted and the water is cold.

And that's only the beginning!

Suppose the electricity in your community has been shut off until further notice. And suppose everyone in your family is in good health and there is plenty of food in the house. You shouldn't have any problems. Right?

Well, without electricity how would you and your family:

Cook your food? ______________________________

Wash the dishes? ______________________________

Open a can? ______________________________

Make toast? ______________________________

Bake a cake? ______________________________

Store food in summer? ______________________________

Store food in winter? ______________________________

Wash the clothes? ______________________________

Keep warm in winter? ______________________________

Have light in your house? ______________________________

Entertain yourselves? ______________________________

Get to the 6th floor of a building? ______________________________

Get a weather report? ______________________________

Communicate with a friend across town? ______________________________

Grade Level: 2-6

Discipline: Science

Objective:

The student will trace the transmission of electrical energy from the power plant to the consumer

Suggested Time: 20 minutes

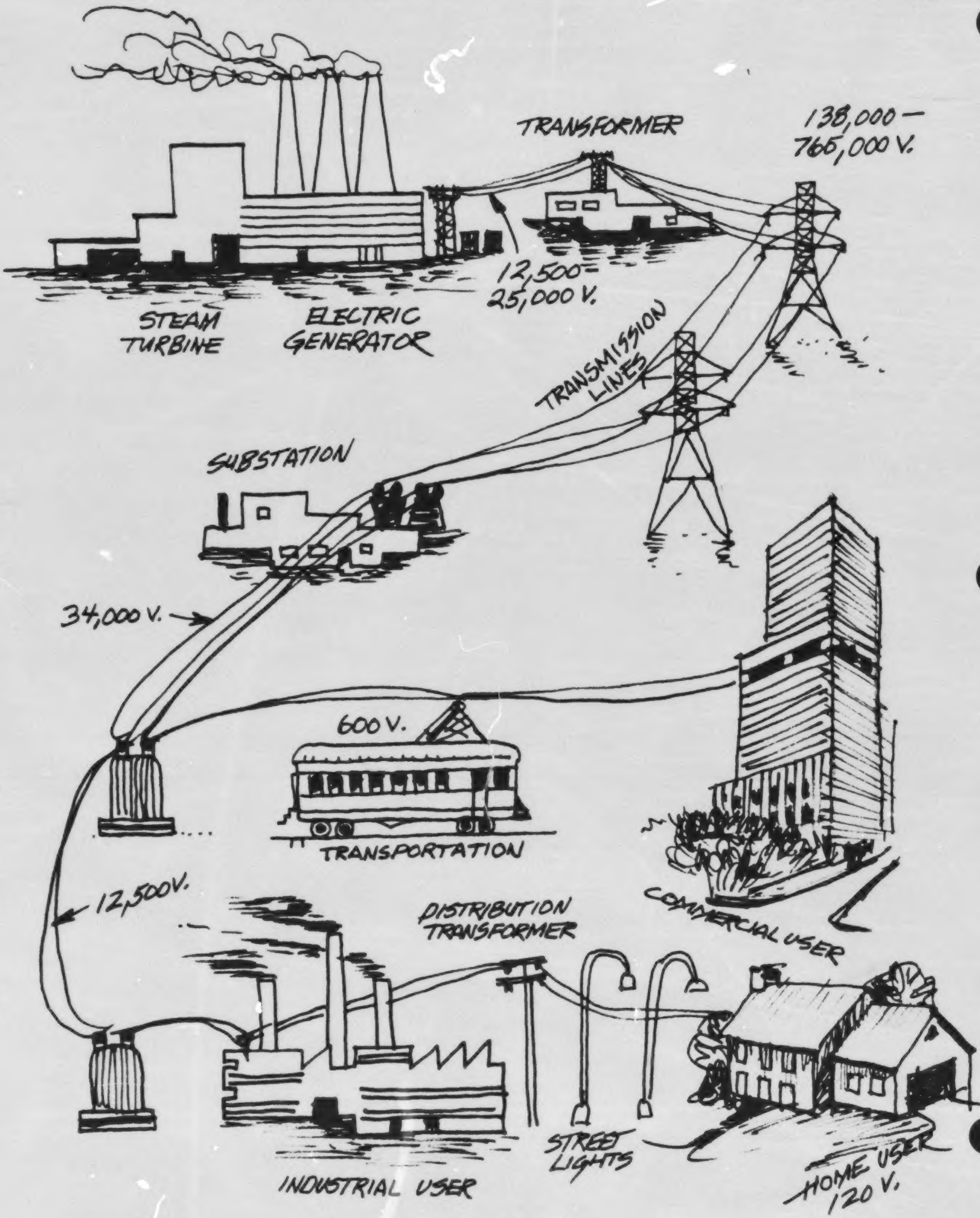
Materials Needed:

"Generation, Transmission, and Distribution of Electricity" that follows

Teacher Notes:

Use the following activities

Generation, Transmission and Distribution of Electricity


TRANSFORMER
138,000 – 765,000 V.
12,500 – 25,000 V.
STEAM TURBINE
ELECTRIC GENERATOR
TRANSMISSION LINES
SUBSTATION
34,000 V.
600 V.
TRANSPORTATION
COMMERCIAL USER
12,500 V.
DISTRIBUTION TRANSFORMER
STREET LIGHTS
INDUSTRIAL USER
HOME USER 120 V.

VIII.

Energy for Transportation

Grade Level: 5, 6

Discipline: Social Studies

Objectives:

The students will develop car use data for their communities

Suggested Time: One week

Materials Needed:

Chart for traffic count, bulletin board, Diagram "Aspects of the Auto," lifestyle survey

Teaching Suggestions:

Explain to the students that you want to help them determine how much their families and the people in the community depend upon autos. Select spots in the community that are main traffic arteries and assign teams of three students to each of these spots. They are to count all of the vehicles that pass the spot in a half hour interval. The teacher should help them choose the best time of day to make the count. The students should also try to count the people in each vehicle. Include the road leading to the school as one of your counting spots. Have each team summarize their results on one of the charts that follows. Use these discussion questions to analyze the results:

What do your vehicle counts tell you about transportation in our community? Consider number of poeple per car, vehicle type, congestion, and road use.

1. Is transportation a problem in our town?
2. What can be done to reduce car use in town?
3. Do you know what a carpool is? Have you ever been in one?
4. What do you think is the best way to get people back and forth from school?
5. Is one location worse for traffic than others in the community? Why?

Make a bulletin board using the auto as a central focus. Ask the students to bring in pictures of any product or resource connected to the auto. (See diagram "Aspects of the Auto.") Use the following questions to discuss the good and bad aspects of the auto and what it has done for our way of life:

1. How does the bulletin board change your idea of the auto?
2. Do you see anything wrong with one invention having such an influence on our lives?
3. What can be done to reduce the use of the auto in our community?
4. How could we solve any traffic problems around our school?
5. What part can you play in changing the impact of the car on the environment?
6. Design a plan for our school and completely omit cars and busses, i.e., put in no parking lots or driveways. Is such a plan practical for our school? Why or why not?

Survey some older people who can remember when cars were much les numerous than they are now. Use the lifestyle survey that follows. Discuss how these people's lifestyles differed from ours. Then discuss the following questions:

1. If the possessions that we have help to make up our lifestyle, how can we have a good lifestyle and reduce the impact on our environment?

2. Do you know of any ways that you help to damage the environment?

3. Do you think that personal possessions are worth more than things like natural areas, clean water, or clean air?

4. Does a good lifestyle mean a poor environment? Explain.

5. Do you think that the adults are taking care of the environment that you will need for your lifetime?

COMMUNITY TRAFFIC COUNT

Location________________

Team Members________________

____

____

Type of Vehicle	Total Number	People (Estimate if necessary)	Average Number of People per Vehicle
Auto			
Truck			
Bus			
Other			

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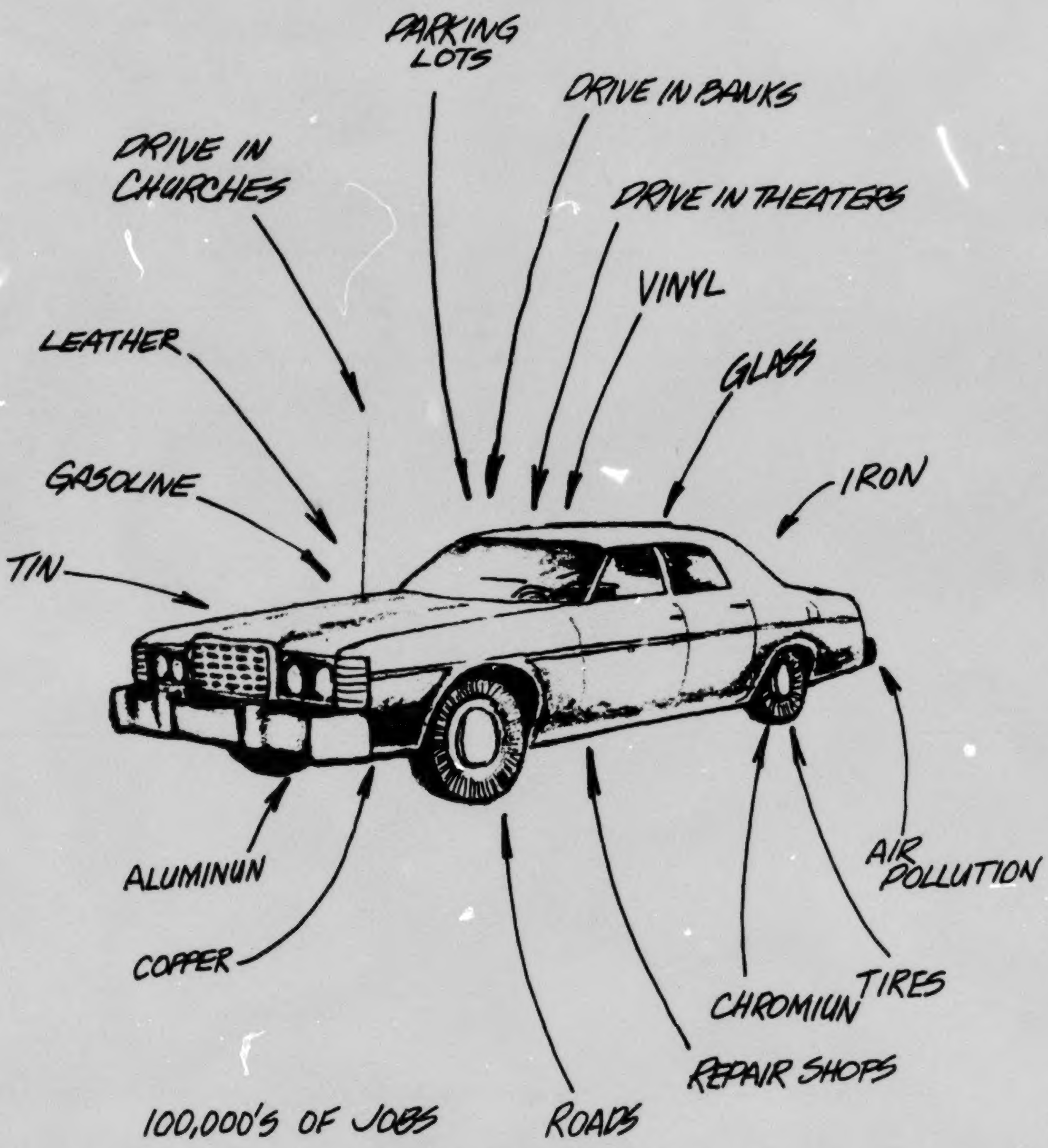
ASPECTS OF THE AUTO


PARKING LOTS
DRIVE IN BANKS
DRIVE IN CHURCHES
DRIVE IN THEATERS
VINYL
LEATHER
GLASS
GASOLINE
IRON
TIN
ALUMINUN
COPPER
AIR POLLUTION
TIRES
CHROMIUN
REPAIR SHOPS
100,000'S OF JOBS
ROADS

LIFESTYLE SURVEY

1. How far back can you remember what your lifestyle was like?
2. How did you get around then?
3. Did people travel long distances on vacations, to and from work, to visit, to shop, to church?
4. What were the roads like?
5. Did you have access to air travel?
6. Are the forms of transportation you used still around? If not, what happened to them?
7. What do you see happening or being built mainly because of the auto?

Grade Level: 6

Discipline: Math

Objectives:

The students will use decimal numbers to solve problems dealing with gasoline mileage.

Suggested Time: One or two class periods

Materials Needed:

- Ditto that follows

Teaching Suggestions:

Introduce the lesson with a brief discussion on the current problem of rising gasoline prices, and the need to conserve gasoline. Discuss the Environmental Protection Agency mileage ratings, and how they are meant to help the consumer. Point out that they are only estimates, and actual milage will differ.

Show students how number of miles driven divided by gallons of gasoline used gives miles per gallon. Work out several examples on the board, and/or have students come to the board and work out examples. You can then assign the ditto sheet that follows. You might want to change the price of gasoline on the ditto to reflect current prices in your community.

M.P.G.

Mr. Smith was in the market for a new car. He was quite concerned with the increasing price of gasoline, so he shopped around to compare the E.P.A. ratings of various cars. Mr. Smith figures that he drives an average of 12,000 miles a year, and the unleaded gas that he would have to use costs $129.9 in his area. With this information, he tried to find a car that he enjoyed and could afford to drive.

For the next three questions, assume that the E.P.A. ratings are accurate, and that gasoline prices remain the same. Find out how much Mr. Smith would pay for gas to drive each of these cars for one year.

1. The first car he looked at had an E.P.A. rating of 20 m.p.g.
2. The second car he looked at had an E.P.A. rating of 24 m.p.g.
3. The last car he looked at had an E.P.A. rating of 16 m.p.g.
4. How much would Mr. Smith be saving each year by buying the car with the E.P.A. rating of 24 m.p.g. instead of the one with the rating of 16 m.p.g.? What assumption are you making that undoubtedly makes this a low estimate?
5. Assume that Mr. Smith bought the car with the E.P.A. rating of 24 m.p.g. He decided to check this figure. The first week he drove 223.4 miles and used 9.5 gallons of gas. What was his actual m.p.g.?
6. Using Mr. Smith's actual m.p.g., what is his driving range if his gas tank holds 14.5 gallons of gas?

All the information about the m.p.g. of Mr. Smith's car so far was in city driving. He knows that his m.p.g. will improve on a long trip.

7. Mr. Smith decided to check his m.p.g. on a long trip. He drove 252.7 miles and used 7.9 gallons of gas. What is his m.p.g. for trips?
8. What is his driving range when he is on a trip?
9. Mr. Smith is planning a trip to Florida, a driving distance of about 1200 miles one way. How much will he pay for gas using his highway m.p.g. and assuming gas prices the same as in his own area?
10. About how many times will Mr. Smith have to stop to fill his gas tank on his way to Florida?

Grade Level: K-4

Discipline: Social Studies

Objective:

The students will investigate alternate modes of transportation

Suggested Time: 20 minutes

Materials Needed:

Activity Master that follows

Teacher Notes:

Follow the directions on the activity master.

THERE ARE OTHER WAYS TO GET FROM HERE TO THERE

Directions: With your house as the starting point in each case, talk with your family about the way to get to each destination listed below and write in the spaces provided (1) the distance in blocks or miles (2) another way of getting there other than the family car and (3) the time in minutes or hours the other methods would take.

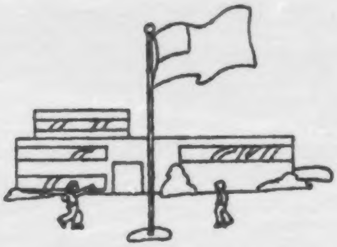
YOUR TOWN

SHOPPING CENTER

TOWN MALL
BANK

1. ____________________
2. ____________________
3. ____________________

YOUR SCHOOL



1. ____________________
2. ____________________
3. ____________________

YOUR HOUSE

PARENT'S PLACE OF BUSINESS

A-JAX
INDUSTRI

1. ____________________
2. ____________________
3. ____________________

FAVORITE RESTAURANT

1. ____________________
2. ____________________
3. ____________________

FRIEND'S HOUSE

1. ____________________
2. ____________________
3. ____________________

IX.

Future Energy Sources

Grade Level: 6

Discipline: **Social Studies, language arts**

Objective:

The student will investigate alternative energy sources

Suggested Time: One class period

Materials Needed

Activity Masters that follow

Teacher Notes:

Follow the instructions on the activity master.

LADIES AND GENTLEMEN OF THE PRESS...

Announcer:
We interrupt our program to bring you this NRG-TV news special. I.M. Wright, chairperson of the committee appointed to study possible energy sources for the new school building, is holding a press conference to announce the foul sources that will be considered and is ready to field questions from the press corps about the choices.

Wright:
Our committee has considered many possibilities, but we've finally narrowed our choices down to four: Solar, Geothermal, Windpower and making oil and gas from coal.

Doogle of The Bugle:
What, exactly, is solar energy?

Wright:
Very simply, *solar energy* is sunlight – *sunlight collected on glass or metal plates or in special solar "cells."*

Bailey of The Daily:
How soon do we run out of solar energy and have to go through all this again?

Wright:
Never! *The sun will shine whether we collect its rays for energy or not. And it won't stop shining if we do use it.*

Parker of The Barker:
That's good news! Now, let's have the bad. How much?

Wright:
Cost? Is that what you mean? *Well, it will be expensive in the beginning to install solar equipment* because of the new technology involved, but once it's in, *heating costs will be cheaper than using conventional systems.* Solar systems will need some kind of back-up heating system to help when the sun doesn't shine. However, using sun energy is *good for the environment.* It pro-vides heat and light for animal and plant life all the time.

Hughes of The News:
Geothermal - what's that? Sounds like a new name for winter wolies!

Wright:
If it were, you really would have a hot seat! *Geothermal energy is steam or hot water from under the earth's surface.* When this steam or hot water pushes through the earth's surface, it makes a hot spring or a geyser - like "Old Faithful."

Parr of The Star:
So, how do we use it for energy?

Wright:
We can pipe it directly into the school to fill the radiators, or we can pipe it to electric plants where it will turn turbines and generate electric power. Then we send it into the school building by wires.

Grimes of The Times:
Four quick questions: How much does it cost? How much do we have? Where is it located? How dangerous to the environment?

Wright:
It's expensive to find the reserviors, which are located mostly in the Western U.S., but once they're found, *steam is low in cost compared to fossil fuels.* Problem is, *we don't have a lot of this energy source.* And it will have *some bad side-effects as far as the environment goes. Wells, roads, ponds, large above-ground pipes and power plants are part of the package.*

Dunn of The Sun:
So why consider it? I heard *it can pollute streams and air, too.*

Wright:
That's true. Well, we considered it because it can be used directly and doesn't need to be mined, or processed, and it makes basically clean heat.

Doogle:
I thought I heard you say coal. Isn't that a step backwards?

Wright:
Not really. *Coal is our most abundant fossil fuel.* 90 percent of out fossil fuel reserve is coal, and we use only a very small amount of it.

Bailey:
If we start using it, won't coal begin to run out, too?

Wright:
Sure it will. But since there's so much of it there, we can use it to buy time for technology to catch up and find and effective alternative to fossil fuels.

Parker:
Isn't coal a terrible pollutant?

Wright:
Burning coal is polluting, but we're considering *gasified and liquefied coal. Gasification removes the sulfur and other pollutants and can give us a substitute for natural gas.* Coal liquefaction is the process of converting coal to a liquid. This liquefied coal can be refined like petroleum and can be transported through existing oil pipelines.

Hughes:
Is this an expensive alternative?

Wright:
It used to look expensive. Now, with the skyrocketing prices of petroleum, *it's starting to look like a bargain.*

Parr:
What's it going to do to the environment?

Wright:
Well, let's just say that the results aren't going to win a garden club award. *Coal first has to be mined; it could destroy thousands of acres of land unless the mines are reclaimed.*

Grimes:
Let's get to *windpower.* What could we do wtih the wind?

Wright:
Like solar, probably only hope to use it to supplement another energy source. But, like the sun, the wind is not something that nations can keep to themselves. *Every nation has a free supply. It requires no mining, and it is non-polluting as it has no dangerous by-products.*

Doogle:
(interrupting) Excuse me, but . . . what do we do if the wind doesn't blow? Get out our oars?

Wright:
That's the obvious problem. The wind would have to blow to create the energy needed to generate electricity.

Announcer:
Sorry, folks, that's all we have time for. Now stay tuned for an INSTANT ANALYSIS.

INSTANT ANALYSIS SCORECARD

The press conference is over. U.R. Baffled, manager of the local movie theatre, stood up and said, "Whew! What'd he say? Did anyone write any of that down?" So, now you've got to play Craiter Wonkite and do an "instant analysis."

Think about what you heard in the press conference. Without looking back at the playlet, try to list as many of the important points mentioned about each energy source. Write your answers in the spaces under each energy source. Once you have finished, you can go back and check your answers with the press conference sheet.

WHAT DID THEY SAY ABOUT. . .

SOLAR ENERGY?

1. Where does it come from?______________________________
2. How much will it cost?______________________________
3. What is its effect on the environment?______________________________
4. Is there a limited supply?______________________________

GEOTHERMAL ENERGY?

1. Where does it come from?______________________________
2. How much will it cost?______________________________
3. What is its effect on the environment?______________________________
4. Is there a limited supply?______________________________

COAL GASIFICATION?

1. Where does it come from?______________________________
2. How much will it cost?______________________________
3. What is its effect on the environment?______________________________
4. Is there a limited supply?______________________________

WINDPOWER

1. Where does it come from?______________________________
2. How much will it cost?______________________________
3. What is its effect on the environment?______________________________
4. Is there a limited supply?______________________________

NOW, put a check mark next to the source you like best and explain why you like it best. Maybe you have a better idea. Maybe you can think of an energy source that is not talked about here. If you can, put a check in the box that says "my suggestion," and use the space at the bottom to explain it. You might also like to see the new school use more than one of these sources. If this is your choice, mark the box that says "a combination of sources," and explain.

☐ **ONE OF THE FIVE ENERGY SOURCES** ☐ **A COMBINATION OF SOURCES** ☐ **MY OWN SUGGESTION**

EXPLAIN:______________________________

____

____

111

Grade Level: K-4

Discipline: Science

Objective:

The student will demonstrate wind power by making a pinwheel.

Suggested Time: 30 minutes

Materials Needed:

Paper, scissors, stick (or plastic straw or pencil with eraser), straight pin, pinwheel pattern that follows

Teacher Notes:

People have harnessed the wind to do work for centuries. Sailors used this energy source for ages. In our own American west, windmills pumped water, sawed wood, and generated electricity for half a century. From 1880 to 1930, over 6 million windmills generated electric power in the west. Then rural electrification and use of other fuels began to replace them. Now that other fuels are so expensive, modern windmills are being developed.

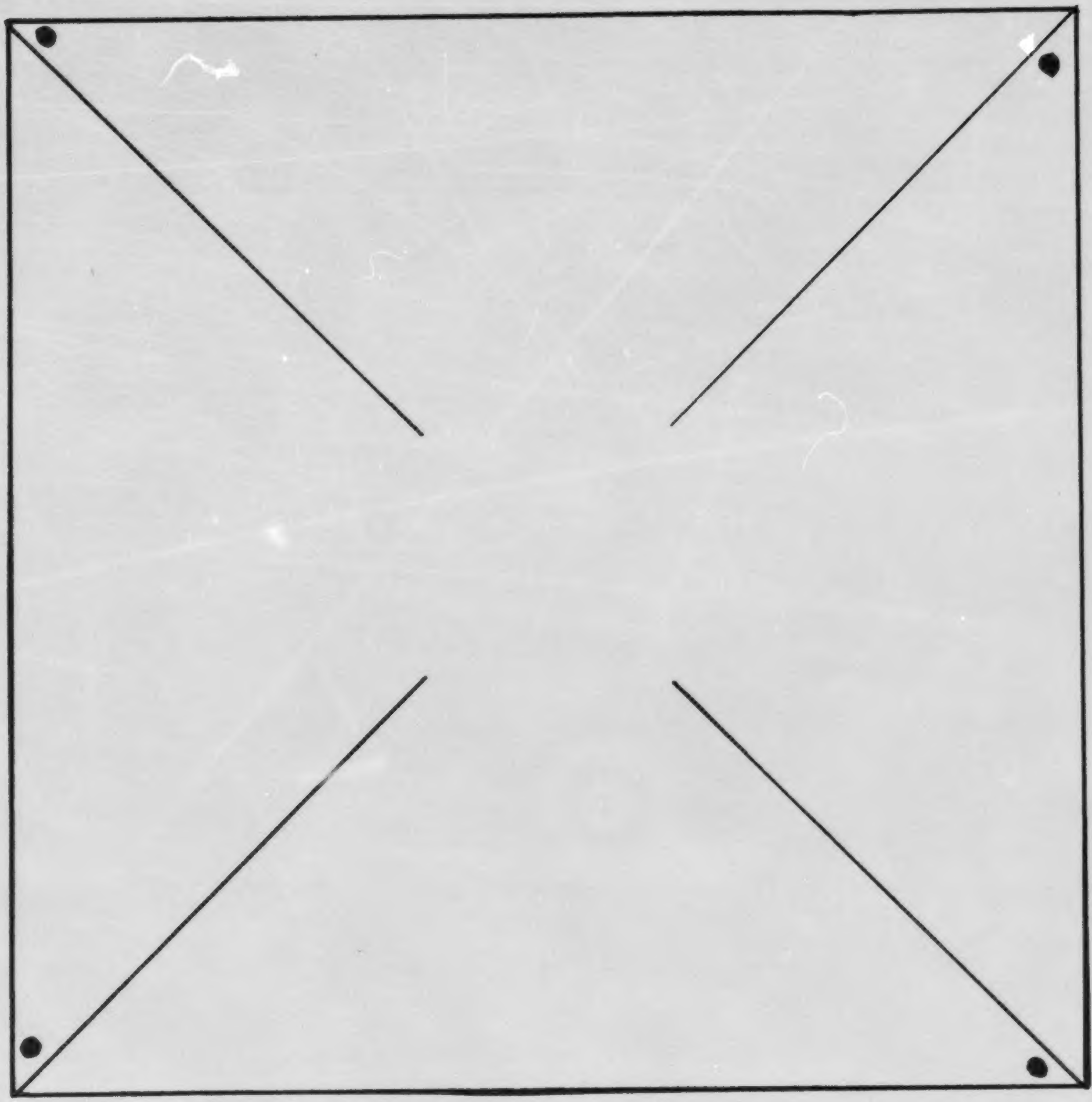
Winds strong enough to use for electrical generation are found in the Great Plains and the northeast states. In those areas it averages more than 12 miles per hour and is constant enough to be of value. Practical wind-driven power plants could generate as much as 20% of our electrical needs by the year 2000.

Wind power requires large initial costs, but there are no fuel costs and no pollution. However, there are objections on esthetic grounds–a very large number of huge wind machines would be necessary to generate any significant amount of electricity. There is also the problem of energy storage, since provision must be made for times when the wind is not blowing. Also, scientists must learn more about wind behavior to find out how much power can be generated and the most efficient equipment to use.

Teaching Suggestions:

Use the pinwheel pattern that follows. Cut out the square and cut along the diagonal lines. Fold over the dotted corners into the center. Stick a straight pin through the center and into a pencil eraser, straw, or stick. Test in the wind if possible.

PINWHEEL PATTERN



Grade Level: K-3

Disciplines: Language Arts, Science

Objectives:

The students will recognize that the wind can do useful work.

Suggested Time: One or more class periods

Materials Needed:

Windmill skit that follows. Read through skit and gather whtever props you feel appropriate

Teaching Suggestions:

If weather permits, take the class outisde on a windy day. Have the students feel the wind and see what it is doing to the trees and bushes. Have them share their feelings about the wind.

Read the poem *Who Has Seen the Wind?* by Christine G. Rosetti

Who has been the wind?
Neither I nor you.
But when the leaves hang trembling
The wind is passing through.
Who has seen the wind?
Neither you nor I.
But when the trees bow down their heads
The wind is passing by.

Discuss the poem in terms of the following questions:

1. Can you really see the wind? Can you see what it does?
2. How can you tell when the wind is blowing?
3. What is wind? How do we use wind?
4. What does wind do that helps us and other people?
5. What does wind do that harms us and other people?
6. How do we use the wind to help us do our work?

Have students perform the windmill skit.

WINDMILL SKIT

This skit opens with one of the characters hearing a poem about the wind, saying. "That reminds me of a story I used to know, about the windmill named Louise". He/she comes around to the front of the stage and begins to read the story from a book, as the actors pantomine it.

Once there was a windmill named Louise. (Windmill, which is two actresses or actors standing one behind the other with arms extended as the windmill blades, comes forward and curtesys, then moves back again.) She lived on a farm in Pennsylvania and the North wind blew strongly there and the windmill moved and produced power for the farm.

(Enter Jed and his wife Ellie)

Jed: Well, Ellie, this here wind is blowing strong. Let's put up a windmill and use the wind to make electricity for the farm.

Ellie: Good idea, Jed. We have some scraps of lumber up at the house. (Gazing) Boy, she'll be beautiful up on that hill! (Enthusiastic) Let's get started.

(As the narrator narrates the next part, Jed & Ellie bring out the Windmill, and make motions of putting it together, tightening screws on joints, etc., until at the end of the narration Jed takes one 'blade' and gives it a push, and the four blades begin seesawing, creating a twirling effect)

They bought a generator to attach to the windmill to make electricity to run their farm.

(In the next part, when the narrator talks about Louise breaking down, one of the blades stops and goes crooked, and Jed comes out and fixes it, then starts the blades turning again)

Louise was very independent. She hardly ever broke down, and when she did, the reancers could repair her themselves, so they were independent, too. It was a very happy threesome for many years. Louise felt happy and useful. Ten one day, things changed. Oh sure, the wind kept blowing, but there were strange people working in the fields. All their activity made Louise nervous. Have you ever seen a nervous windmill? (windmill trembles) Well, neither had they, and they didn't seem to notice that day either. (two men enter, wearing hard hats if possible)

Worker #1: Drop that line over here. Bring that crane forward. Don't worry about the crops, just get it over here. We got power lines to put up.

Worker #2: Hey, Ed, look at that old windmill. These new power lines oughtta put her out of work.

And they did. It wasn't long after that that Jed and Ellie came out and disconnected Louise's generator.

Jed: Well, Louise, we have to shut you down. You have been good to us, but now we can plug in to get our power whenever we want it.

Ellie: I just have to flick a switch. But Louise, it has been a real pleasure working with you. (Windmill and Ellie shake hands)

Louise had a sad face as her blades were locked for good. To be honest, she became bored. (Windmill yawns) The days were much longer now. Louise wanted to feel the wind spinning her blades. She began to look shabby. She moaned on stormy nights and, if you listened closely, (but nobody ever did) you could hear her softly weeping. (One of the back arms of the windmill reaches around and pulls a handkerchief out of the pocket of the front actor and holds it up to the front actor's nose: she/he blows loudly)

One wind day, Louise overhears Jed and Ellie in the garden (Windmill puts blade to ear in listening stance). Jed sounded mad.

Jed: That blasted weather, Ellie – look at the land – can't grow a thing on it, in this dry spell. There's not going to be much of a cash crop this year. (He takes a bill from his pocket, slaps it into his hand). And look a this bill for our power. No matter how we cut back on electricity, the bill just gets bigger and bigger!

Ellie: Where are we going to get the money to pay the bill? Not from this crop, that's for sure.

Jed: I don't know, Ellie, I just don't know.

(Jed and Ellie freeze – Jed like the Thinker, sitting on a stump and Ellie like American Gothic, standing next to him)

But Louise had an idea. (Windmill inches toward them. She leans over and taps Jed on the shoulder)

Jed: (reacts strongly) What was that?

Ellie: It was nothing, Jed, it was just the wind.

Jed: That wind. It blows strong.

Something clicked in Ellie's head. (sound of traingle-ting! And Ellie scratches head) Didn't Jed say that once before? She couldn't remember. (Windmill taps Jed again)

Jed: (Reacts strong again) What was that?

Ellie: I told you, it was nothing; just the wind.

Jed: That dadburned wind, it never quits blowing. What good is it?

(Windmill clears throat - Ahem!)

Sunddenly Ellie remembers - a time 40 years ago when they knew what the wind was good for.

Ellie: Jed, that's it! The windmill! The windmill! (She shoves him on the shoulder, knocking him off the stump)

Jed: (collecting himself) Yeah! We can sell it!

Ellie: No, no, we can *use* it; remember, that's why we built it!

Jed: You're right; let's give it a try.

So Louise went back to work. (Jed and Ellie go through the pantomine of fixing up the windmill, and getting the blades to turn again - They put it on a big tower and change the blades to curve downward) It was a particularly windy summer and she generated all the electricty for for farm. Not only that, Jed and Ellie decided to build another windmill to help them pump water. The crop was saved! (Back part of the windmill steps out and stands next to the front part, blades still turning)

Ellie: Just think, Jed, a two windmill family!

(All four join arms and sing the Windmill Song)

Windmill Song

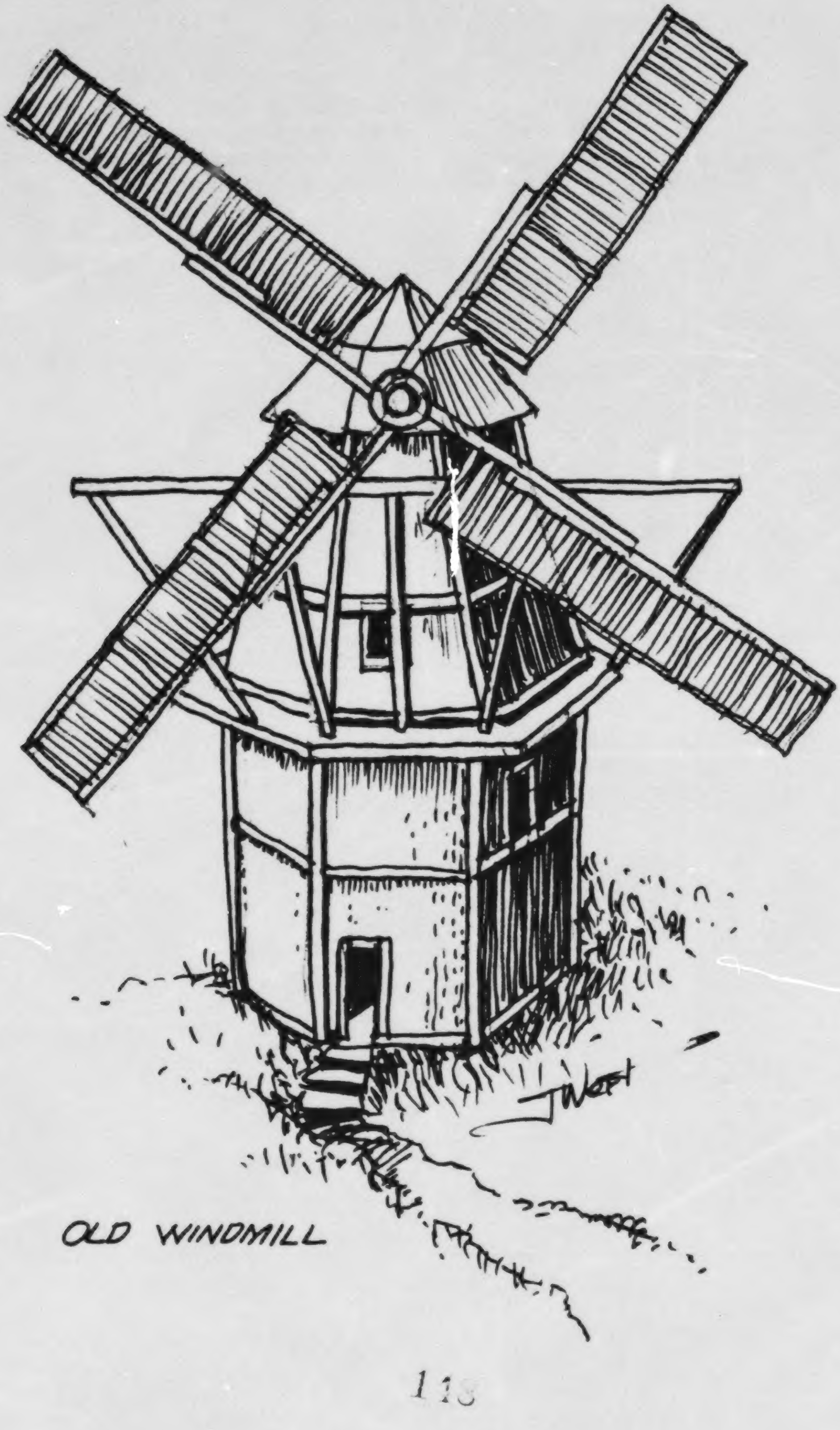
(All) Two little windmills sittin' on the hill
Can save you money on your power bill

(1st Windmill) I'll pump water for your crops

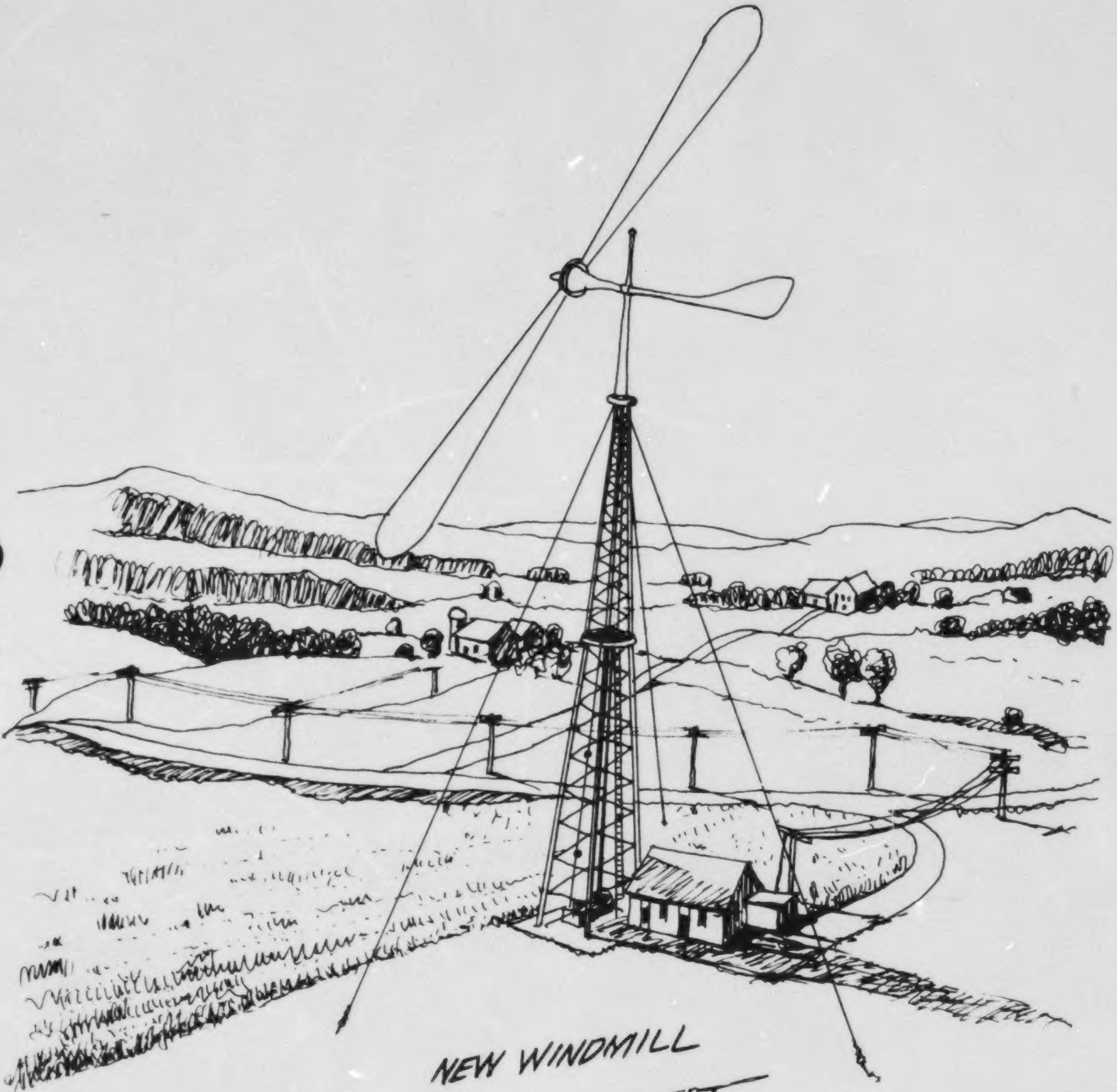
(2nd Windmill) I'll make e-lec-tri-ci-tee!
The secret of windpower lies in its simplicity.

(differnet tune, rhythm)

(All) Oh wind, it keeps blowin'
Tho no-one seems to know that it's their friend;
If they only knew what it can do,
Then they'd never say "It's nuthin' just the wind"



OLD WINDMILL



NEW WINDMILL

JWERT

Grade Level: 1-4

Discipline: Science, Art

Objective:

The students will illustrate and demonstrate the use of wind energy.

Suggested Time: As needed

Materials Needed:

Miscellaneous building materials such as milk cartons, construction paper, tin cans, blocks of wood, sails of cloth or plastic, wheels, hardware

Teaching Suggestions

Have the students draw as many ways as they can think of for using the energy of the wind. Urge them to be creative and not just stick to conventional things like sailboats and windmills.

Divide the class into small groups and let each group make a model of a wind-driven vehicle, using the materials that you have gathered plus any others that might be available. Test the vehicles to see which works better. Can the students determine why the winner was best?

Grade Level: 5, 6

Discipline: Science

Objective:

The student will make a model of how winds are caused on earth.

Suggested Time: 20-30 minutes

Materials Needed:

Cardboard or wooden box, pane of glass or clear plastic to fit over the largest side of the box, 2 lamp chimneys or cardboard tubes, candle

Teaching Suggestions:

Cut out the largest side of the box and cover it with the clear material. Cut two holes in the long side of the box. Secure the tubes or chimneys over the holes. Place a short candle under one of the openings. Light the candle. Observe what happens. Trace the air currents by holding a smoking paper over the chimney without the candle.

The candle represents a warm region of the earth's surface. The smoke goes into the box through the hole where there is no candle, and then back out of the box through the hole where the candle is. This happens because the warm air is lighter than the cold ari and is being pushed up by the cold air.

Grade Level: 4-6

Discipline: Science

Objective:

The student will demonstrate how sunlight can produce high temperatures.

Suggested Time: One class period

Materials Needed:

Magnifying glass, thermometer, flashlight reflector, different kinds of materials (wood, paper, cloth, plastic sheet, rubber)

Teaching Suggestions:

Using a magnifying glass, direct the sun's rays on different materials and observe the results. (CAUTION: Beware of flames. It is best to do this outdoors.)

Using the magnifying glass, focus a beam of light on the end of a thermometer and note the sudden rise in temperature.

Put a thermometer through the hole in a flashlight reflector. Place the bulb of the thermometer so that the sun's rays are focused on it. Observe what happens to the thermometer readings over a period of time. Record findings on a chart.

Grade Level: 3-5

Discipline: Science

Objective:

The student will demonstrate the effect of color on the trapping of solar energy.

Suggested Time: 45 minutes

Materials Needed:

6 test tubes with one-hole stoppers, 6 thermometers, water, sheets of black, blue, red, white, and green colored paper, aluminum foil

Teaching Suggestions:

Fill each test tube with water, stopper, and insert a thermometer into each tube through the hole in the stopper. Record the initial temperature of the water on a chart. Behind each test tube, place one of the sheets of colored paper and the aluminum foil. Place the test tubes in direct sunlight. After five minutes of sunlight, read the temperatures again and record. Repeat this procedure at intervals for about 30 minutes. What can be said about the color background and temperature change?

Repeat the experiment, this time wrapping each tube completely in colored paper and one in aluminum foil. Are there any differences observable between the two sets of data? Try to explain the differences, if any.

A modification of this system could be the use of colored cloth instead of colored paper.

Can you see any application of this experiment to the use of solar energy in the home? Explain.

Grade Level: 2-5

Discipline: Science

Objective:

The student will build a solar reflector and demonstrate its use.

Suggested Time: One class period

Materials Needed:

Old umbrella or similar shape, aluminum foil, beaker of water, thermometer, tongs, protective gloves

Teaching Suggestions:

Remove the handle of the umbrella and line the inside carefully with foil. Focus the sun's rays with the umbrella on the beaker of water. Hold the beaker with tongs or protective gloves. Record the initial temperature of the water and the temperature after five minutes. Compare results. Guide the students into a discussion of the potential use of solar energy to produce steam to run turbines, to heat homes, and to cook food. CAUTION: do not let eyes get close to focal point.

Grade Level: 6

Discipline: Science

Objective:

The student will construct a workable model of a liquid type flat plate collector.

Suggested Time: 2-4 class periods

Materials Needed:

See worksheet that follows

Teaching Suggestions:

Use the student worksheet that follows to have teams of students construct a solar collector. An information sheet on solar collectors is also included.

Student Worksheet **Name** ______________________________

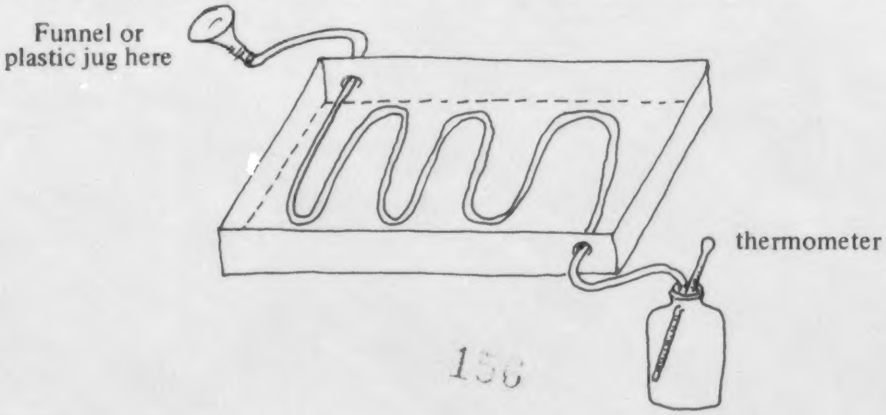
Constructing a Liquid Type Flat Place Collector

Objective to construct a workable model of a liquid type flat place collector.

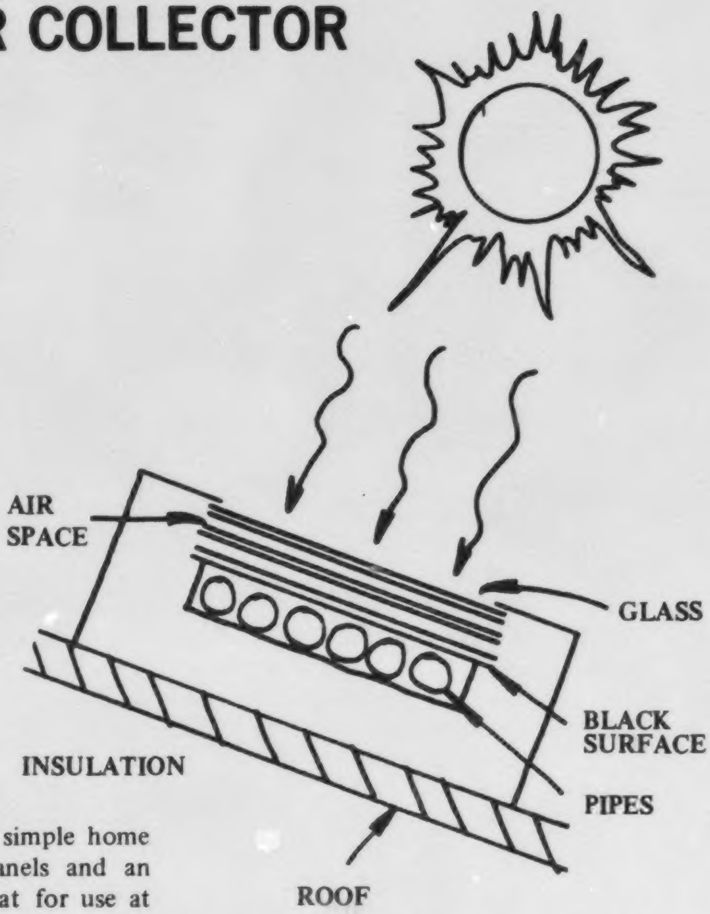
Materials: cardboard box 60-100 centimeters long and 30-60 centimeters wide, a funnel, two plastic jugs, some plastic tubing, plastic or duct tape, a thermometer, some cheap plastic, and some extra cardboard or styrofoam.

Procedure:

1. Cut the box down until it has a depth of from 10-15 centimeters.
2. Pierce holes in the opposite ends of the box as shown in the diagram.
3. Insert the plastic tubing into the box as indicated by the diagram. It may be necessary to attach tubing to the bottom of the box.
4. Cover the collector with cheap, transparent plastics and tape in place to insure a tight seal. The transparent cover is called glazing. A second layer of plastic should be added but apply in such a way as to provide an air space between the layers.
5. The sides and bottom should be insulated by adding anouther layer of cardboard or styrofoam. Be sure all cracks are sealed. The sides can be cut so they are a little high and this will provide a raised edge for application of the second layer of plastic (glazing).
6. A funnel can be attached to aid in circulating water through the system or a plastic jug with a hole in the bottom can be attached.
7. Another plastic jog can be attached at the other end to catch the heated water. The thermometer can be used to measure the increase in temperature.
8. The jug can be insulated to aid in maintaining the temperature (becomes a storage tank much like those in solar homes).
9. A return tube can be added to permit recirculating of the water if a small pump is available.
10. The collector works best facing the sun and tilted at about a 55° angle (latitude plus 15°).



SOLAR COLLECTOR



Over 20% of Pennsylvania's energy is consumed for space heating, hot water heating, and air conditioning. Solar energy is well suited to provide part of the low temperature heat these tasks require, and the technology for utilizing this energy is advancing rapidly. Solar energy has the potential to significantly reduce Pennsylvania's fuel consumption in the future if barriers to its use can be overcome.

The biggest obstacle at present is price. Solar energy systems are more expensive than conventional ones (oil, gas, or electric). Moreover, a conventional backup heating system is still a necessity in the northern states such as Pa. because a typical solar energy system cannot supply total heating requirements during the winter months.

The two basic components of a simple home system are solar energy collector panels and an energy storage device which stores heat for use at night or during bad weather when sunshine is not available. The roof-mounted collector panels usually contain black metal plates that absorb the sun's radiant energy to heat fluid circulating through them. The heated fluid then flows to the energy storage device where it gives up its heat before returning to the collector panels to receive more energy. Solar systems can convert about 50% of the sun's radiant energy into heat.

In solar hot water heaters, the water itself can serve as the circulating fluid and a well-insulated tank holds the heated water until it is needed. In space heating systems, air, or more often water (treated with anti-freeze if necessary) is used as a circulating fluid. Large tanks of water, huge bins of rocks or pebbles, or tanks of special meltable salts have been used to store heat energy for solar space heating systems.

* *

REMEMBER: Many of out conventional energy resources such as oil, gas, and uranium are not expected to last through the next century. As these fuel supplies become more difficult and difficult and expensive to obtain, new sources of energy will become more economical substitutes.

Source: Pa. Energy Primer (non-copyrighted)

Grade Level: 5, 6

Discipline: Science

Objective:

The student will construct a diorama house which uses the sun's warmth for heating.

Suggested Time: 2-4 class periods

Materials Needed:

Cardboard or other materials for building small houses, small dishes of water, thermometers.

Teaching Suggestions:

On a sunny day, take the class into a room on the sunny side of the school building. Then take them into a room on the shaded side. Ask the students if they could feel any difference in the air temperature of the two rooms. Discuss briefly.

Guide the students in the planning and building of several diorama houses which would utilize the sun's warmth for heating. Encourage the use of different materials and styles. Place the completed houses on the window ledge in a sunny room, so that the sun's rays enter the houses as much as possible. Record the temperature of the air or of a small dish of water inside each house. After some period of time, chekc the temperatures again and record. Discuss possible reasons for any differences in temperature in the various houses. Which has the best design and materials for solar heating?

(Adapted from Energy and Scarcity: Environmental Ed. Instructional Activities, The University of the State of NY, Albany, NY.)

Grade Level: 6

Discipline: **Science, Language Arts**

Objective:

The students will do research on various energy alternatives.

Suggested Time: One week

Materials Needed:

Encyclopedias, periodicals, books, and pamphlets

Teaching Suggestions:

Divide the class into several groups. Assign each group one energy alternative and have them research and report to the class. Include such alternatives as fusion, solar heating and cooling, solar electrical generation, wind power, geothermal power, energy from ocean thermal gradients, bioconversion, and other alternatives you or the students may suggest.

X.
Energy Conservation

Grade Level: 5, 6

Discipline: Science

Objective:

Students will be able to read their home electric meters. Students will help their families institute conservation measures and compute the amount of electricity saved.

Suggested Time:

Materials Needed:

Worksheets that follow

Teaching Suggestions:

Reproduce the activity on the next two pages for each student. This is an excellent project for students to do with their parents' assistance. Share the results at the end of the week of conservation measures.

Student Activity: Reading Electric Meters

On the wall of your home you will find an intricate glass-enclosed device. If you are like most people, you seldom pay any attention to it. Nor do you need to, for modern electric meters perform their job so accurately and reliably that you need never to troubled. Every month or so, a man from your electric utility company comes to read it, and later you are billed for the exact amount of electricity used in your house. This activity is designed to teach you to read an electric meter so that you can monitor your family's use of electricity.

Through your meter's glass enclosure, you can see a revolving aluminum disk and a series of dials and pointers, or digital numbers. Without explanation, they don't make much sense, but they are really quite simple. The amount of electricity you use determines the speed at which the disk moves. The more electricity you use, the faster it turns. Each revolution represents a portion of an electric energy unit called a watt-hour. This watt-hour measurement is transferred from the disk through a series of gears to the digital numbers or pointers on the dials. Every hour a 100-watt light bulb burns, it uses 100 watt-hours of electric energy. Since a watt-hour is such a small unit of energy, your electric utility company uses a unit equal to 1,000 watt-hours–a kilowatt-hour–to measure the amount of electricity used.

Friction inside the meter is all but elimintec with the use of a magnetic-suspension system which uses a magnetic field to float the disk and its shaft in air. To help maintain accuracy provided by the magnetic suspension and other design features, the meter is sealed with filters which keep its interior free of dust and other contaminants which can cause innaccurate meter registration. Meters have changed a great deal in the last 20 years. They have had to. Television, electric heating, more lights, freezers, air conditioners, water heaters, and other new appliances have more than quadrupled the average family's consumption of electric power. Twenty years ago a meter rated at 600 watts was enough to meet average household requirements. Today's meters are capable of handling up to 48,000 watts.

Two types of meters are used by electric companies: digital and dial meters. The digital meter is read directly from left to right as shown in Figure 1. Readings on some digital meters are obtained by multiplying by 10. Your local utility will tell you if this is the case in your area.

Figure 1
Digital Kilowatt-Hour Meter

8 2 9 0 = 8,290 kwh

0 8 2 9 0 = 8,290 kwh

0 8 2 9 X 10 = 8,290 kwh

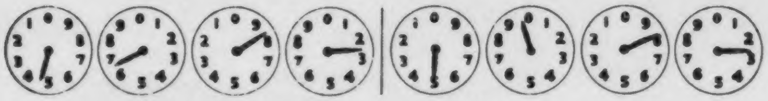
Most meters have four or five dials. (See Figure 2) To read such a meter, stand directly in front of the dials. Read the dials from left to right. Some of the dials move in opposite directions from each other, but regardless of that, always read the smaller figure when the hands are between two numbers. For instance, in the left box of Figure 2, the reading is 4682.

If the hand of the first dial appears to be directly over a number, read the next dial to determine whether or not the hand has passed zero. If it hasn't reached zero, use the next lower number on the first dial. The reading on the dials in the right box should be 4982.

The figures on the dials represent kilowatt-hours, which signify the number of kilowatts flowing through your meter multiplied by the length of time.

Figure 2

Dial Kilowatt-Hour Meters



Now that you have learned to read your electric meter, you are ready to monitor your family's use of electricity and see the results of some conservation efforts.

Read your electric meter at home and record the reading. A.____________________

Read exactly one week later and record the reading. B.____________________

Subtract B from A to determine kilowatt-hours used during the first week of the experiment. C.____________________

During the second week, encourage your family to conserve all the electricity possible. At the end of the second week, again read the meter and record. D.____________________

Subtract D from B to determine the kilowatt-hours used the second week of the experiment. E.____________________

Subtract E from C to determine how much electricity your family saved over the previous week. F.____________________

1. Were you successful in conserving, or did you use more electricity?
2. If you used more, can you explain why?
3. Why would someone with an electricity-heated home have to consider the temperature during the two weeks?
4. List all the energy-saving steps you family took.

Grade Level: 4-6

Disciplines: Math, Social Studies, Language Arts, Home Economics

Objectives:

The student will be able to calculate the amount of electricity used in the lighting fixtures in his/her classroom and school building.
The student will estimate how much money his/her school would be able to save by reducing the number of lights by 1/3.
The student will compare/contrast modern lighting with colonial lighting.
The student will prepare a lighting conservation plan for his/her school.
The student will apply the principles learned to a home lighting conservation plan.

Suggested Time: Three 40 minute periods

Materials Needed:

Different kinds of light bulbs, a light meter (if available), worksheets that follow.

Teacher Notes:

The following definitions and tables will help you in this activity:

Incandescent lamp	electric bulb which glows with intense heat and light (filament heated by current). Called hot light. Efficiency increases with increasing wattage.
Fluorescent lamp	tubular electric lamp. Light produced by fluorescence of phosphors coating the inside of tube. Called cool light. Gives 2 1/2 times as many lumens per watt as incandescent bulbs. Lasts 20 times longer.
Watt	A unit of measurement of electricity
Kilowatt	1000 watts
Lumen (lm)	a measure of light output
Opaque	not transparent
Reflectances	surfaces which cast back light
Foot candle	the illumination on one square foot of which is one foot away from a standard candle.

LIGHTING FOR ENERGY CONSERVATION

OUTPUT OF VARIOUS TYPES OF LIGHTING

Type of Lighting	**Lumens/watt**
Low Pressure Sodium	100-130
High Pressure Sodium	80-100
Metal Halide	40-80
Fluorescent	40-80
Mercury Vapor	40-60
Incandescent	22

SUGGESTED LEVELS OF LIGHT FOR SCHOOL AND HOME

1 deklaux = 10 lux = .9293 footcandles
1 foot candle = 1.076 dekalux

		dekalux	foot candle
School	Auditoriums		
	assembly	16	15
	exhibition	32	30
	Library		
	reading areas	32	30
	study & note taking	75	70
	Locker rooms	22	20
	Classrooms		
	science	110	100
	study	75	70
	note taking	75	70
	Corridors & stairways	22	20
Home			
	Dining room	16	15
	Kitchen	160	150
	reading	32	30
	general lighting	15	11

(from *Illuminating English Society Lighting Handbook*)

Hints

Use the proper reflectant materials for good lighting.
Maintain your fixtures - keep them free of dirt
Use selective switching and dimming in large multi-purpose rooms
Turn off lights when not needed
Remove 2 lamps in a 4 light fixture and disconnect the ballast whenever possible.

REFLECTANCES

Walls should be 40-60%

Ceilings should be 70-90%

Floors should be 35-50%

Silver		90-92%
Chromium		63-66%
Aluminum:	Polished	60-70%
	Alzak polished	75-85%
Stainless steel		50-60%
Clear glass or plastic		8-10%
White paint		70-90%
White porcelain enamel		60-83%
White plaster		90-92%
White terra-cotta		65-80%

White porcelain enamel		60-83%
Limestone		20-40%
Sandstone		20-40%
Marble		30-70%
Gray cement		20-25%
Granite		20-25%
Brick:	red	10-20%
	light buff	40-45%
	dark buff	35-40%
Wood:	light birch	35-50%
	light oak	25-35%
	dark oak	10-15%
	mahogany	6-12%
	walnut	5-10%
Paint:	New white paint	75-90%
	old white paint	50-70%

Teaching Suggestions:

Have the students examine different kinds of light bulbs which you can obtain to share with the class. The cardboard package around the bulbs gives the watts and lumens for each bulb.

Discuss the difference between incandescent and fluorescent bulbs. Describe the difference between a light fixture, lamp, and bulb.

Ask the students to read the story **Bright Light** and to unscramble the words and play the game. Discuss the differences in how we light our homes today compared with how they lit their homes in the colonial days. Have the students transfer the knowledge learned in this activity by developing a *Save a Watt* plan for their own homes or apartments. Use the worksheets provided for this activity.

Schools are becoming increasingly aware of the energy costs in running their systems. A medium-sized school system can spend $100,000 for electricity, much of it for lighting.

Your school's cost for electricity can be found in the school budget which your Business Administrator or Superintendent has. You might want to find the cost and share this information with your class.

You might also wish to obtain a light meter and measure the foot candles for different areas of your school. Ask the custodian to describe the kinds of fixtures and the wattage used in the school building, and how the lighting fixtures are cared for. Discuss colors used on wall and ceiling surfaces in the building which can make the building brighter.

Have students complete the worksheets for the school. Then incorporate the best ideas from the class in a letter to the school board recommending ways to save money on electricity used for lighting.

BRIGHT LIGHT - A COLONIAL VIEWPOINT

The first way of lighting the house of Colonial America was by use of Pine-Knots. These were gathered from the fat pitch-pine which grew in abundance throughout the Colonies. These knots were referred to as candle wood and were the main source of illumination from New England to Virginia in the 1600's. When burned, candlewood emitted brihgt light, smoke, and pitchy tar drippings. Because of this, the candlewood was usually burned on a flat stone in the corner of the fire place. The pitchy tar that dripped from the pine knots became a valuable trade product of the colonists.

Until people began to raise domestic animals, candles were costly luxuries selling at four pence apiece. As animals were domesticated, frugal farm wives saved every ounce of tallow. Wicks were spun from hemp, cotton, or milkweed. Making candles was an autumn task, and a hard one, for the entire winter's stock of candles was made at one time. Two large kettles were placed on the fire and each was filled with half boiling water, half tallow. At the cooler end of the kitchen, two long poles were laid across the backs of two chairs. Across these poles were placed smaller sticks called candle rods. To each candle rod was attached 6 to 8 wicks. A rod with its row of wicks was dipped into the melted tallow and then returned to its place across the poles. Each rod was dipped in turn, cooling between dips. The candles *grew* until after about 30 dips they were the thickness desired.

Wax candles were also made. They were often shaped by hand, by pressing bits of heated wax around a wick. Farmers kept bee hives as much for the wax as the honey.

Rush lights were made by stripping part of the outer layer from common rushes, thus leaving the pith bare, then dipping them in tallow or grease and letting them harden.

Colonists found that the oil from whales was a vast and cheap supply of oil for their metal and glass lamps. Toothed whales have a valuable material called spermaceti stored in their heads. Spermaceti was used for making candles and it is said that these candles gave out three times the light of a tallow candle and had four times as big a flame.

Betty-lamps were small shallow receptacles, either oval, round, or rectangular, with a spout an inch or two long. They usually had a chain by which they could be hung on the back of a chair. Betty-lamps were filled with grease or oil, and a piece of a cotton rag or wick ran down the spout into the oil. From this wick, dripping grease, came a dull, smokey flame.

For many years, simply striking a light was very primitive. Nearly all families had some form of steel and flint. By striking these two together over a piece of tinder (line or vegetable matter), a spark would be emitted and would fall on the tinder. The spark was then carefully blown into a flame. The flint, steel, and tinder were usually kept together in a tinder box.

Charles Dickens said tht if you had good luck, you could get a light from the tinder box in a half an hour.

Because the process of producing a flame was so difficult, fires in fireplaces were carefully banked during the night in the hope that cinders would still be *alive* by morning. If by ill fortune the fire in the fireplace totally *died* during the night, someone was sent to the nearest neighbor carrying a shovel or covered pan in which to bring back live coals for rekindling the fire.

The first practical matches were *Congreves* invented in England in 1827. Eighty-four of these matches were sold in a box for twenty-five cents.

Unscramble these words that relate to methods of colonial lighting.

1. nekstoip ____________ dowo lednac ________________
2. neldacs ____________ lowtal ________________
3. sicwk ____________ odr cdalne ________________
4. xeeswab ____________ hurs tighls ________________
5. Ealhw lio ____________ amserptociee ________________
6. Sapmll ytetb ____________ tinlf ________________
7. elets ____________ tiredn ________________
8. dlinkireng ____________ Songcever ________________

Use the unscrambled words to help you remember some important facts about lighting. The number beside each blank is a clue to tell you which row it may be found in.

(1)______________________ were the first way of lighting colonial houses.

Pine knots were called (1)______________________.

(6)______________________ held oil and wicks for lighting.

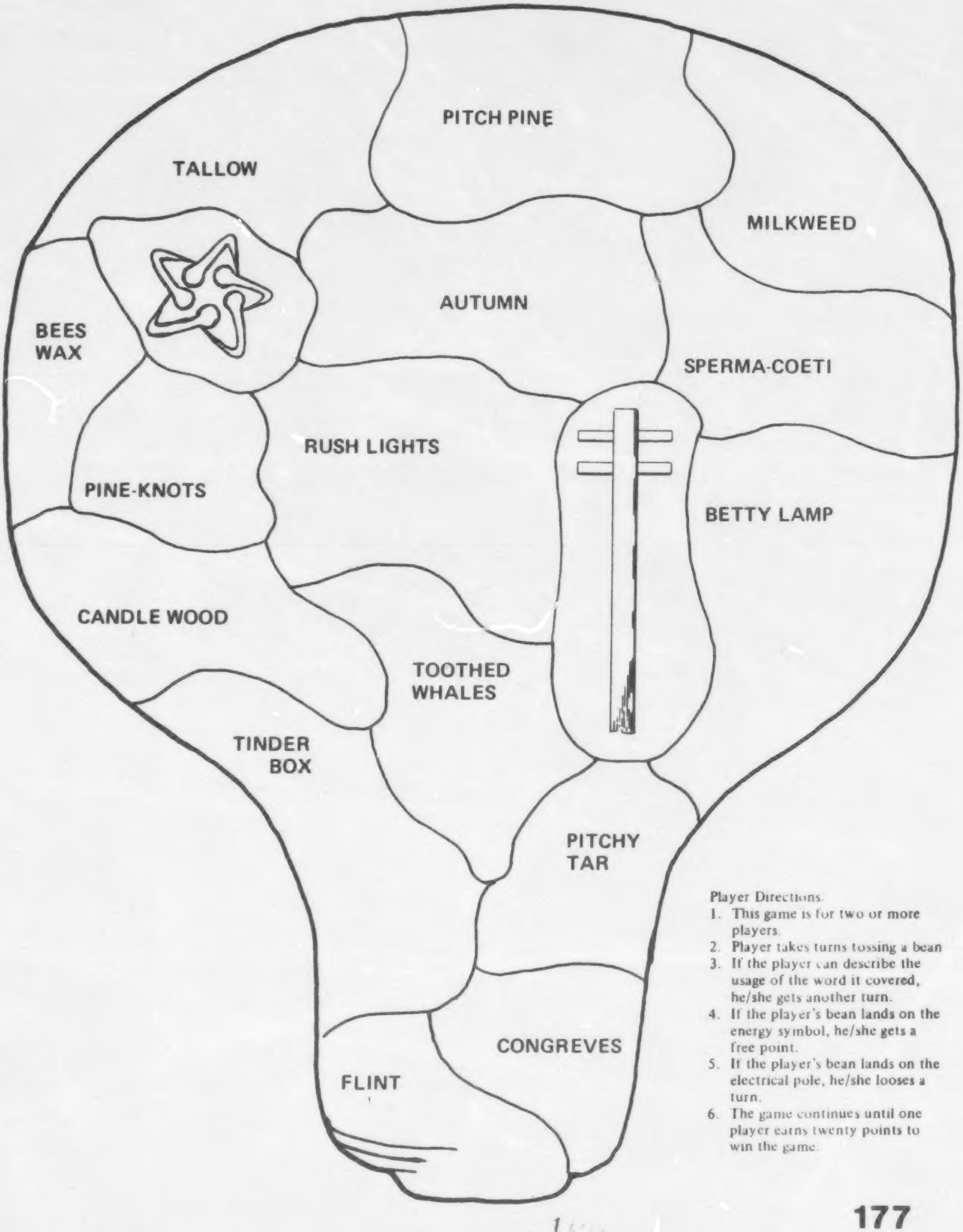
Taken from a whales head (5)__________________ produced excellent candles.

It was not until 1827 that (8)__________________ invented matches.

The (3)______________________ held many wicks that were dipped into a tallow pot.

1. pineknots	candle wood
2. candles	tallow
3. wicks	candle rod
4. beeswax	rush lights
5. whale oil	Sperma-Coeti
6. Betty lamp	flint
7. steel	tinder
8. rekindling	Congreves

BRIGHT LIGHT


PITCH PINE
TALLOW
MILKWEED
AUTUMN
BEES WAX
SPERMA-COETI
RUSH LIGHTS
PINE-KNOTS
BETTY LAMP
CANDLE WOOD
TOOTHED WHALES
TINDER BOX
PITCHY TAR
CONGREVES
FLINT

Player Directions.

1. This game is for two or more players.
2. Player takes turns tossing a bean
3. If the player can describe the usage of the word it covered, he/she gets another turn.
4. If the player's bean lands on the energy symbol, he/she gets a free point.
5. If the player's bean lands on the electrical pole, he/she looses a turn.
6. The game continues until one player earns twenty points to win the game.

HOME
"SAVE A WATT"
PLAN

Look around your home for ways to save on electricity used for lighting.

In space below, write down your ideas. Go ahead, think conservation!

HINTS

Leave blinds open on sunny days - use natural light instead of light bulbs whenever possible.
Keep all bulbs and fixtures clean.
Replace opaque shades with transparent shades.
Replace incandescent bulbs with flourescent bulbs.
Keep all lights off when no one is in the room.
Use bulbs with the lowest wattage possible considering safety and use of the room.

"SAVE A WATT" IN MY HOME

1. Count the lighting fixtures in your home or apartment. (some lamps have more than one fixture).

2. Count the number of bulbs in each fixture.

3. List the number of watts for each bulb in each fixture. (Give each fixture a number.)

4. Count or estimate the hours per day that you use each fixture.

5. How many of these fixtures are incandescent?
Fluorescence?

Facts to remember

1 100w bulb (incandescent) provides 1740 lm
1 60w bulb (incandescent) provides 860 lm
1 40w bulb (incandescent) provides 600 lm
1 20w bulb fluorescence provides 1600 lm
1 40w bulb fluorescence provides 2850 lm

5a. Do 2 60w incandescent bulbs give more light than 1 100w incandescent bulb?

5b. How many 20w fluorescence bulbs would be needed to produce the same output as 1 100w bulb?

5c. Do you use any incandescent light bulbs in your home for heating?

5d. Are all bulbs clean?

5e. Could any be replaced by others with lower wattages?

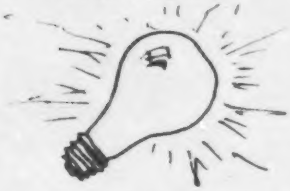
6. How many lamp shades in your home are opaque?

7. What lights get left on when they are not being used?

8. Find out the cost per kilowatt hour for electricity used. (Call your utility company).

9. Estimate how many hours each fixture is on a day.

"SAVE A WATT"
IN MY HOME

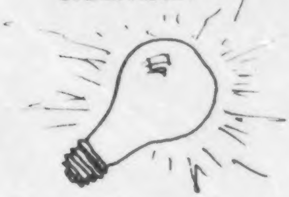


10. Chart this information for a week.

Lighting *fixture*	kwh = $\frac{\text{watts x hours/day x 7}}{100}$	*cost* ____¢ x kwh
	Total ____________	Total ________

11. Make up a lighting conservation plan for your home.

SCHOOL
"SAVE A WATT"
CAMPAIGN



Look around your classroom and your school in general. Is electricity being wasted in the way things are lighted? Probably so. In the space below, write down your ideas of as many ways as possible that energy for lighting could be saved. Consider in your ideas the different times of the year and different times of day.

An example could be that on sunny days the lights could be left off. You should be able to list at least 5-8 examples yourself.

Go ahead, think conservation!

Possible Ideas

Open blinds when light is dim, allowing some lights to be left off.
On normal days, leave lights nearest windows off.
On very bright days, leave lights off completel.
Remove alternate light bulbs and ballasts from fixtures.
Use fluorescence lighting instead of incandescent.
Clean bulbs and fixtures periodically.
Turn off lights completely during class discussions or talks.
Turn all lights off when room is empty.
Lower amounts of hallway and restroom lighting. Use only the amount of light needed for safety.

SCHOOL
SAVE A WATT WORKSHEET

NAME ______________________

DATE ______________________

1. Count how many light fixtures are in your classroom? ______
2. How many light bulbs in each fixture? ______
3. How many light bulbs are in your classroom? ______
4. Find out the amount of wattage for each bulb. Calculate the total wattage for each fixture. ______ ______
5. Estimate how many hours the light fixtures are on. ______
6. Calculating the number of kilowatt hours by multiplying the number of watts by the number of hours used, and dividing by 1,000, how many kilowatt hours do the fixtures burn *in a day?* ______
   In a week? ______
   In a year? ______
7. How many killowatt hours does your classroom use in a school year? ______
8. If you turned off 1/3 of the lights in your classroom *for a day* how many kilowatt hours would you save? *For a day?* ______
   For a week? ______
   For a year? ______
9. If every classroom in your school turned off 1/3 of their lights for a year, estimate how many kw hours they would save. ______
10. If a kilowatt hour costs approximately 6 cents, how much does it cost to run the lights in your classroom *for one day?* ______
    For a week? ______
    For a year? ______
11. How much does it cost to run the lights in all the classrooms in your school *for one day?* (See No. 8 & 9) ______
    For a week? ______
    For a year? ______
12. If one ton of coal burning in a furnace produces about 2577 kilowatt-hours of electricity, how many tons of coal are used by your classroom *in a school day?* ______
    In a school week? ______
    In a school year? ______
13. If every classroom in your school turned off 2/3 of the lights for a school year, how many tons of coal would be saved? See #12) ______

After you have computed all this information - write to your School Board recommending some ways to save energy in lighting.

Grade Level: K-4

Discipline: Social Studies

Objectives:

Students will suggest ways to save energy given different situations.

Suggested Time: as needed

Materials Needed:

Situation Cards and illustrations that follow.

Teacher Notes:

Energy conservation is both a national problem and an individual one. The United States, with only about six percent of the world's population, uses 33 percent of the world's energy. We have wasted energy in the past because it has been cheap and abundant, or so we thought. Today, with fuel prices rapidly escalating and with perilous economic conditions and our dependence on foreign oil, we are beginning to realize that conservation is the cheapest, safest, cleanest, and wisest way to cope with our energy problem on a short-term basis. The need is for education to change behaviors and attitudes concerning our use of energy. These situations and illustrations are designed so that students can think critically about how they and their families and schools can save energy.

Teaching Suggestions:

The following situation cards can be used by students individually or in groups. Reproduce as many as you need and cut them out and distribute them. Have students decide which actions to take on each situation, and analyze whether these are helping to save energy. Have students pose as many alternative actions as possible.

The *Energy Saver-Energy Waster* illustrations that follow can be made into transparencies or posters. Discuss each illustration with the students. Have them describe what in each illustration is energy saving, and what is energy wasteful. Have students suggest ways of changing the situation to save energy. Hints are on the back of each illustration to aid teachers.

DINNER?

Situation Card #1

It is a hot summer day and Mom asks for suggestions for dinner. Would you:

A. Pile in the car and drive to a drive-in restaurant.
B. Tell Mom you want roast, potatoes, bread.
C. Start the charcoal in the outdoor grill for hamburgers.
D. Eat a cold salad.
E. Other. . .

CAMP IN THE DARK?

Situation Card #2

You go camping with your family one weekend. In the evening, you would like to read a book before going to bed. Would you:

A. Use the campfire for reading.
B. Use a flashlight in your tent.
C. Forget about reading and sing songs with your family around the fire.
D. Go to bed.
E. Other. . .

SHOWER OR BATH?

Situation Card #3

Mom wants you to wash up every day, but she warns you not to be wasteful! Would you:

A. Insist on hot showers all the time.
B. Learn to get clean in cool showers.
C. Learn to take showers instead of baths.
D. Take a quick bath each day.
E. Other. . .

HOW DO I GET THERE?

Situation Card #4

You live two miles from school and your parents have left it up to you to decide the best way to get to school each day. Would you:

A. Start out early and walk.
B. Ask Mom or Dad to take you in the car.
C. Ride a bus.
D. Ride your bicycle.
E. Other. . .

BRRR!!

Situation Card #5

It is very cold outside, the house doesn't feel too warm, and your sister is not feeling well. Would you:

A. Turn up the thermostat so she doesn't catch a chill.
B. Put warm clothes and a blanket on her.
C. Start a fire in the fireplace.
D. Other. . .

CHILLS

Situation Card #6

On the first cold winter day you feel a draft coming through the windows. Would you:

A. Ask Dad to caulk the windows.
B. Help Dad put on storm windows.
C. Turn up the thermostat.
D. Close the curtains.
E. Other. . .

SURPRISE

Situation Card #7

Dad surprises Mom with a clothes dryer on her birthday. Mom is so excited she says she will never have to hang clothes on the line again! Would you suggest to your Mom that she:

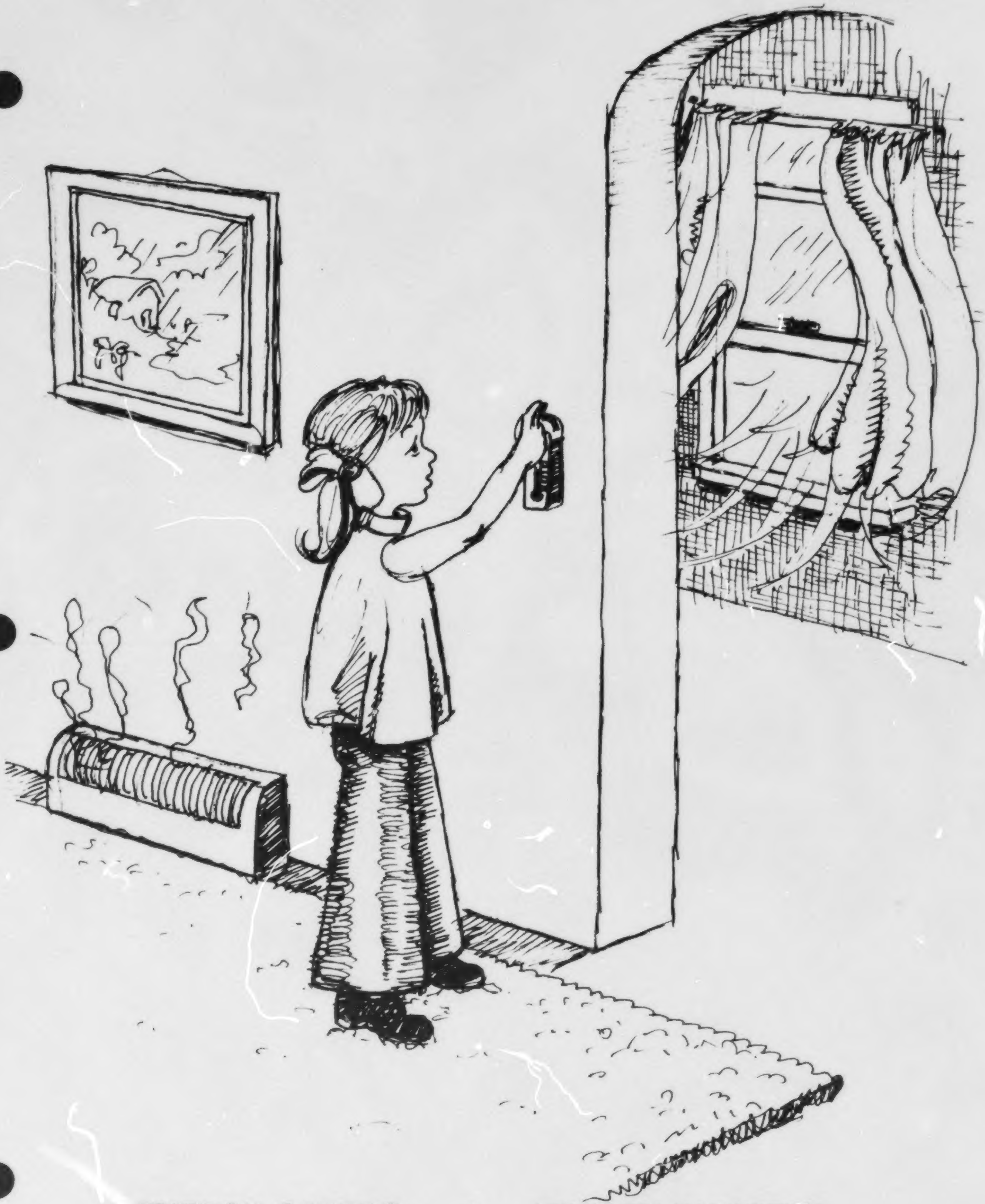
A. Hang clothes outside when it is nice.
B. Use the dryer all the time.
C. Dry small loads whenever she wants to.
D. Other. . .

COOL IT!

Situation Card #8

On a hot summer day you want to get cooled off. Would you:

A. Turn on the air conditioner.
B. Turn on the fan.
C. Jump in the nearest pool.
D. Fan yourself with a stiff piece of paper.
E. Other. . .



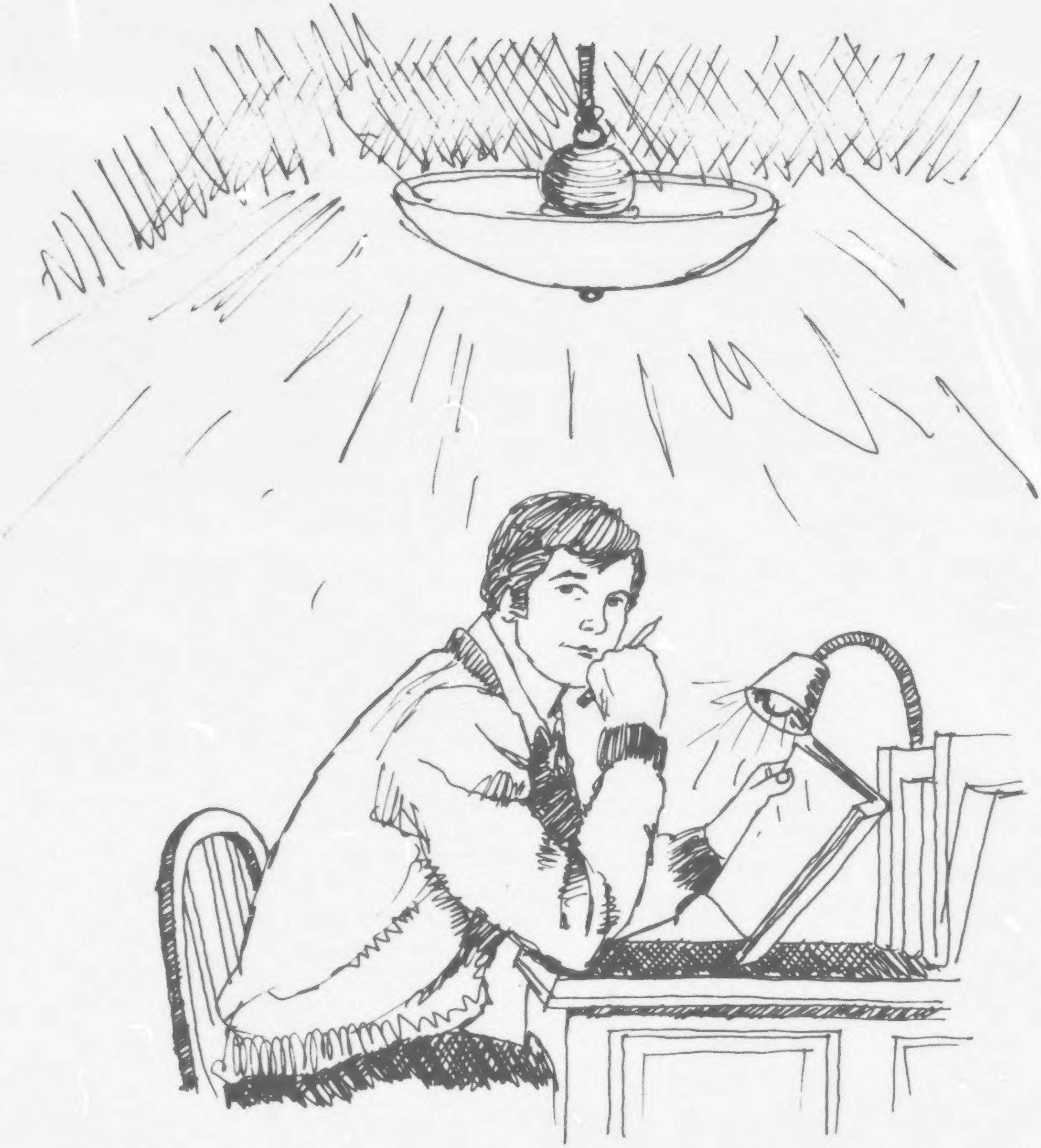
ENERGY SAVER?

ENERGY WASTER?

HINTS:

The child in the illustration has a short sleeved shirt on which indicates she may be cold. She could put a sweater on instead of turning up the thermostat.

In the other room the window is open. The draft from the window will make the furnace work harder and use up more energy.

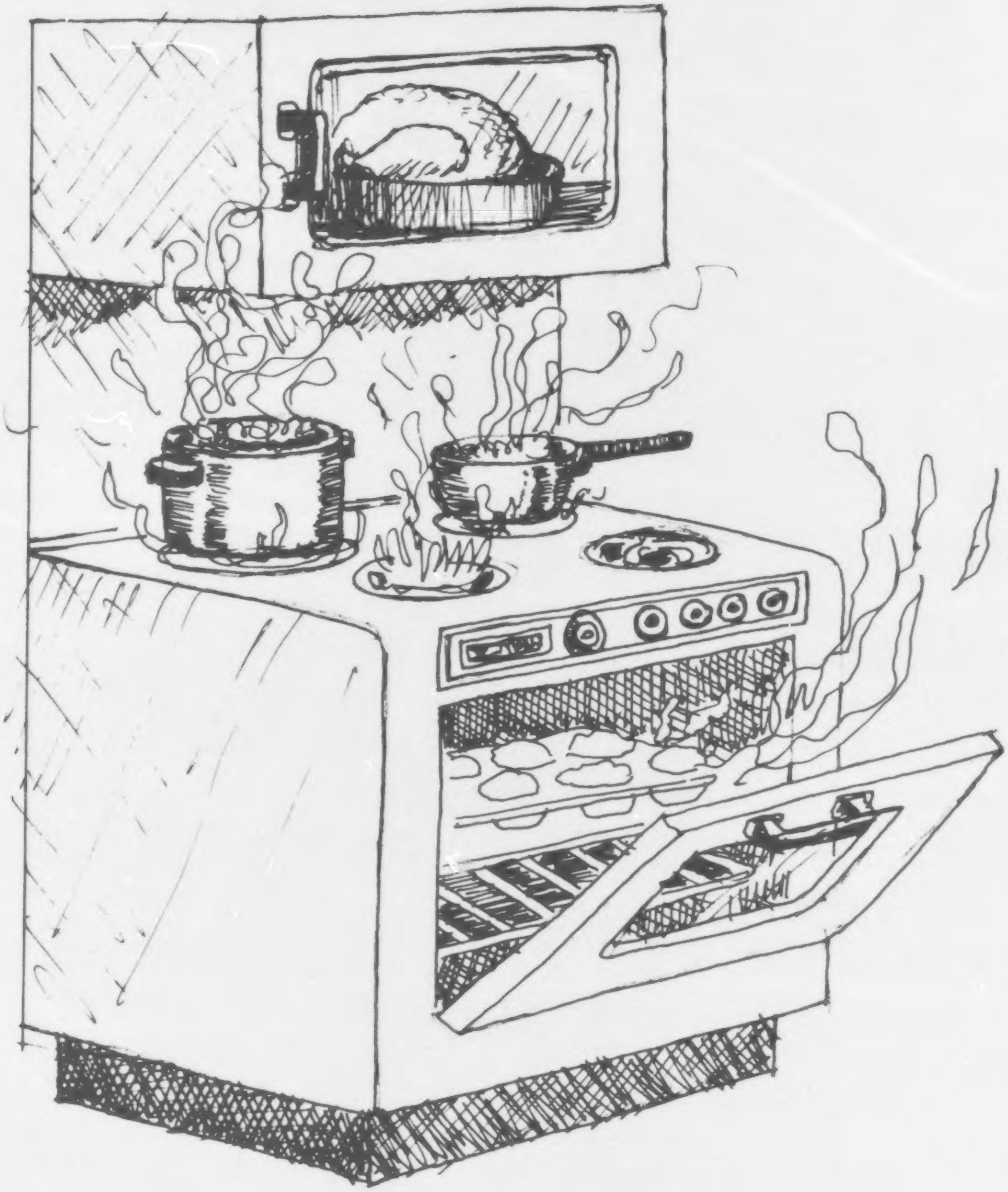


ENERGY SAVER?	ENERGY WASTER?
1. ________________	1. ________________
2. ________________	2. ________________

HINTS:

Task lighting is all that is needed for this boy to have proper light to study.

Fluorescence instead of incandescent light bulbs would be an added energy saver.



ENERGY SAVER?	ENERGY WASTER?
1. ________________	1. ________________
2. ________________	2. ________________
3. ________________	3. ________________

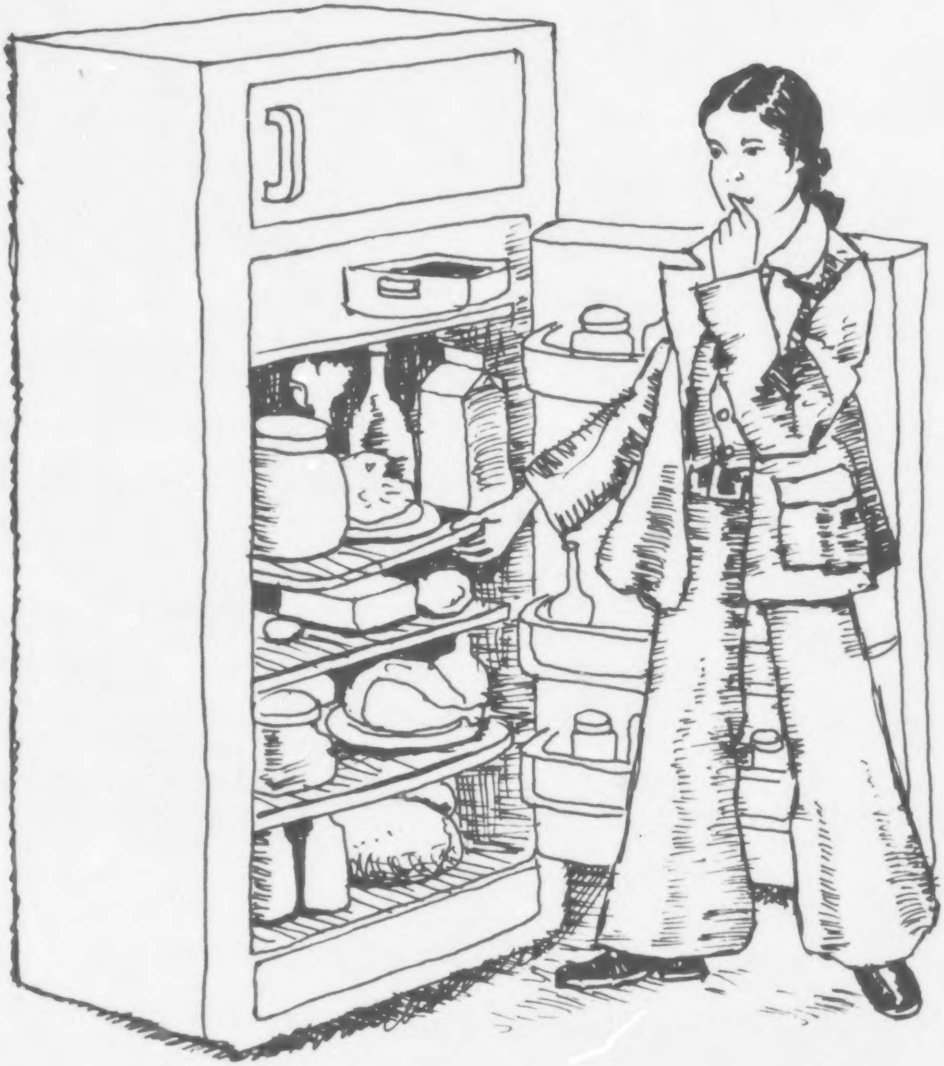
HINTS:

Both ovens are in use and one has been left open, perhaps to heat the kitchen.

One burner is on without a pan on it and both pans are boiling over, without lids.

Much energy can be saved if meals are planned to use as little cooking area as possible. Even using small electrical appliances instead of a range and oven can save energy.

Fitting pans to the right burner, using lids, using correct temperature to cook all save energy.

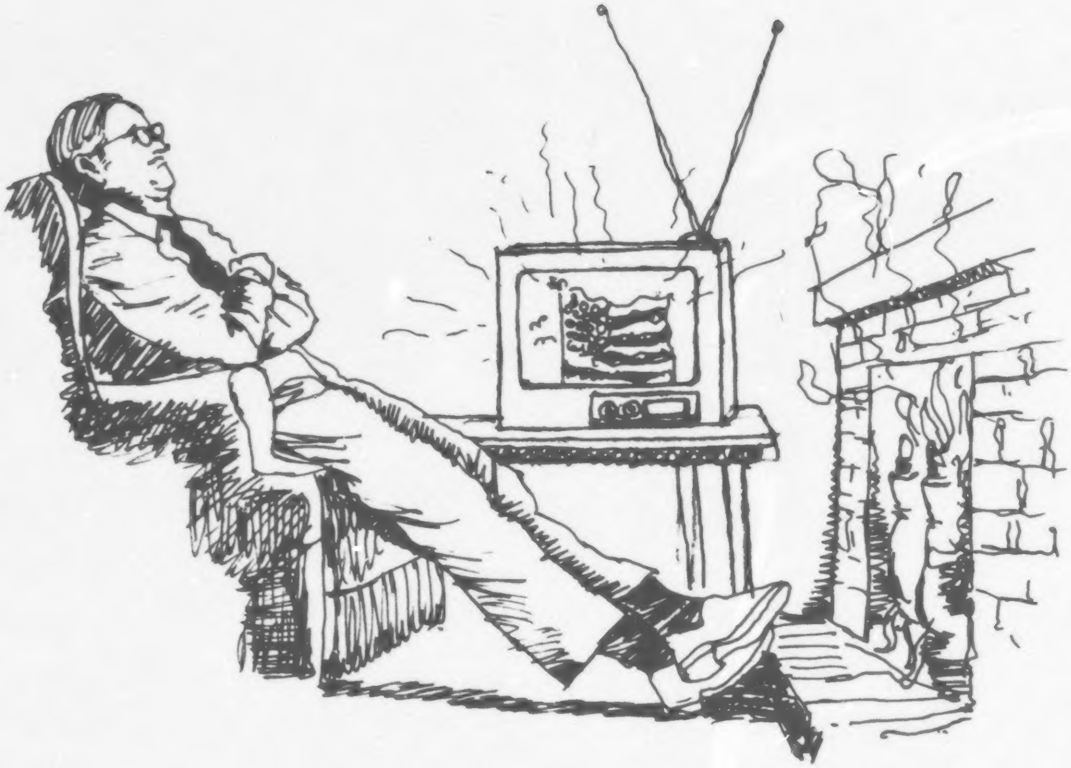


ENERGY SAVER? ENERGY WASTER?

HINT:

Deciding what you want out of the refrigerator while keeping the door open is an energy waster.

Quickly opening and closing a refrigerator door as few times as possible will save energy, as well as help to keep the refrigerator frost-free.



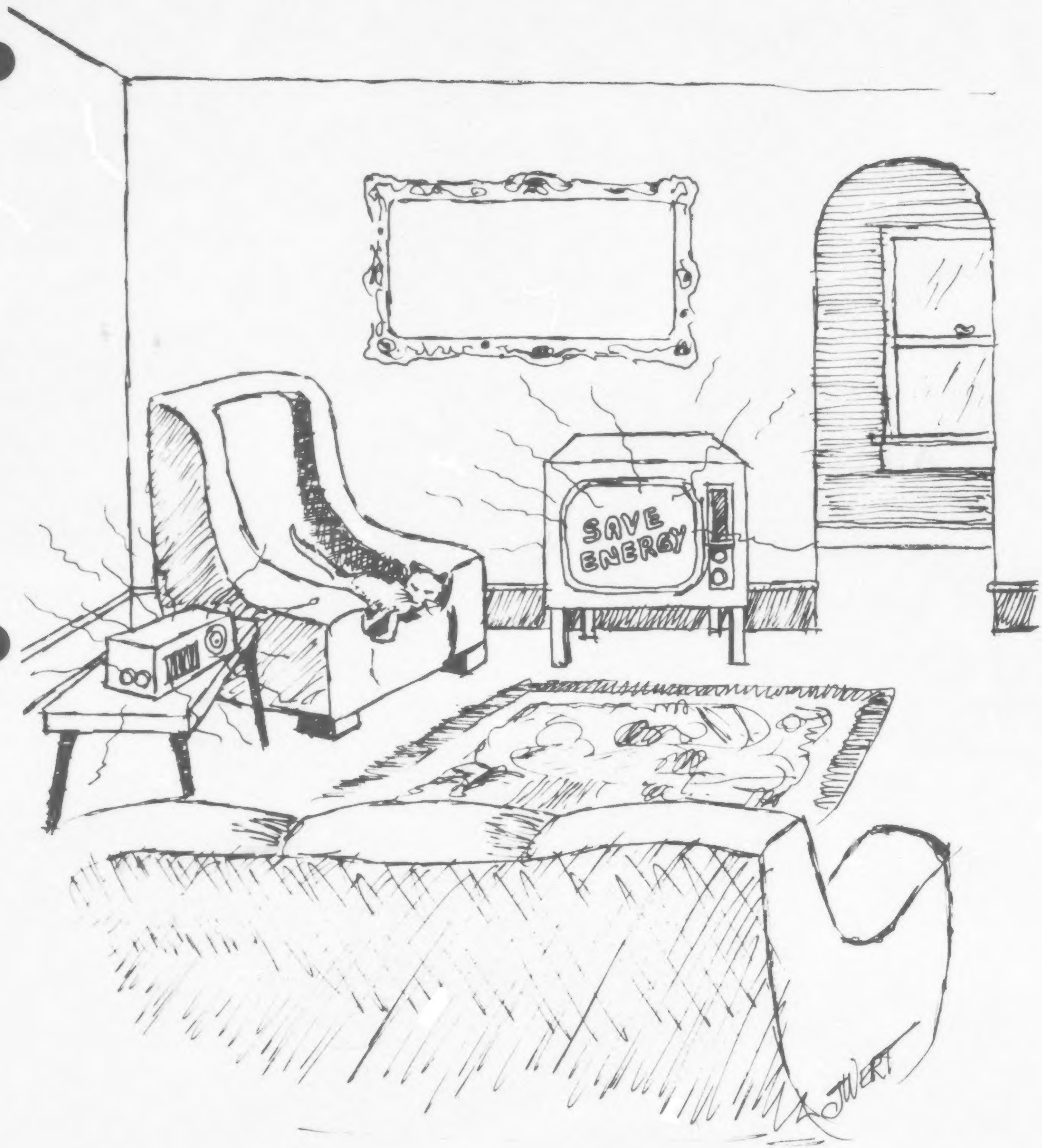
ENERGY SAVER? **ENERGY WASTER?**

HINTS:

Dad has fallen asleep in his favorite chair while the fire is blazing and the TV is on.

The open fire (without a screen) is a fire hazard and an energy waster. Warm Air is drawn from the house up the chiminey. The furnace works harder to warm up the cooler air left. A wood burning stove or glass doors in front of the fireplace would improve the energy efficiency of the fireplace. Closing dampers when the fireplace is not in use will also save energy.

Someone should turn off the TV while Dad sleeps!

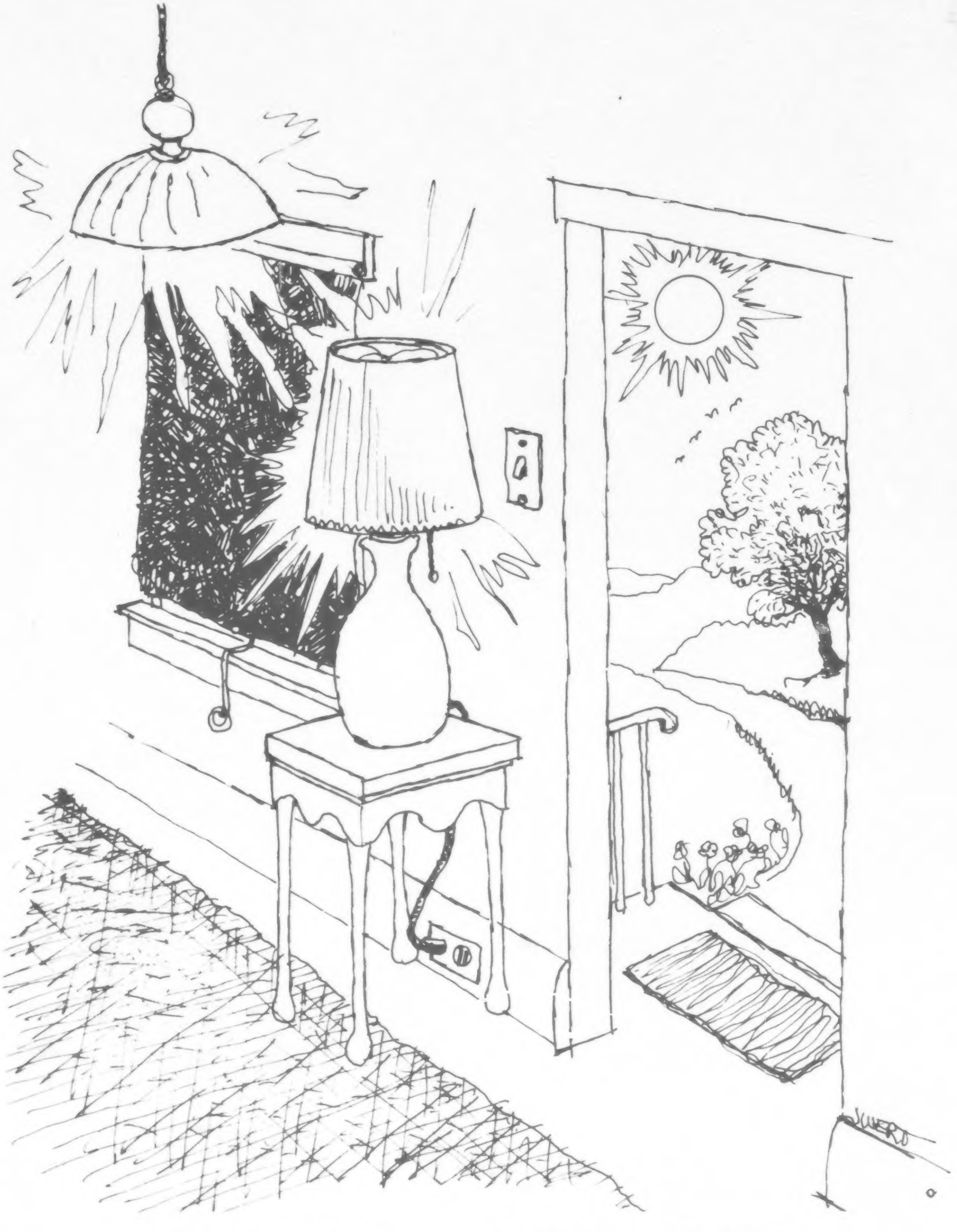

SAVE
ENERGY

ENERGY SAVER? ENERGY WASTER?

HINTS:

In this illustration, the cat is the only one to hear what is being communicated on the radio and TV.

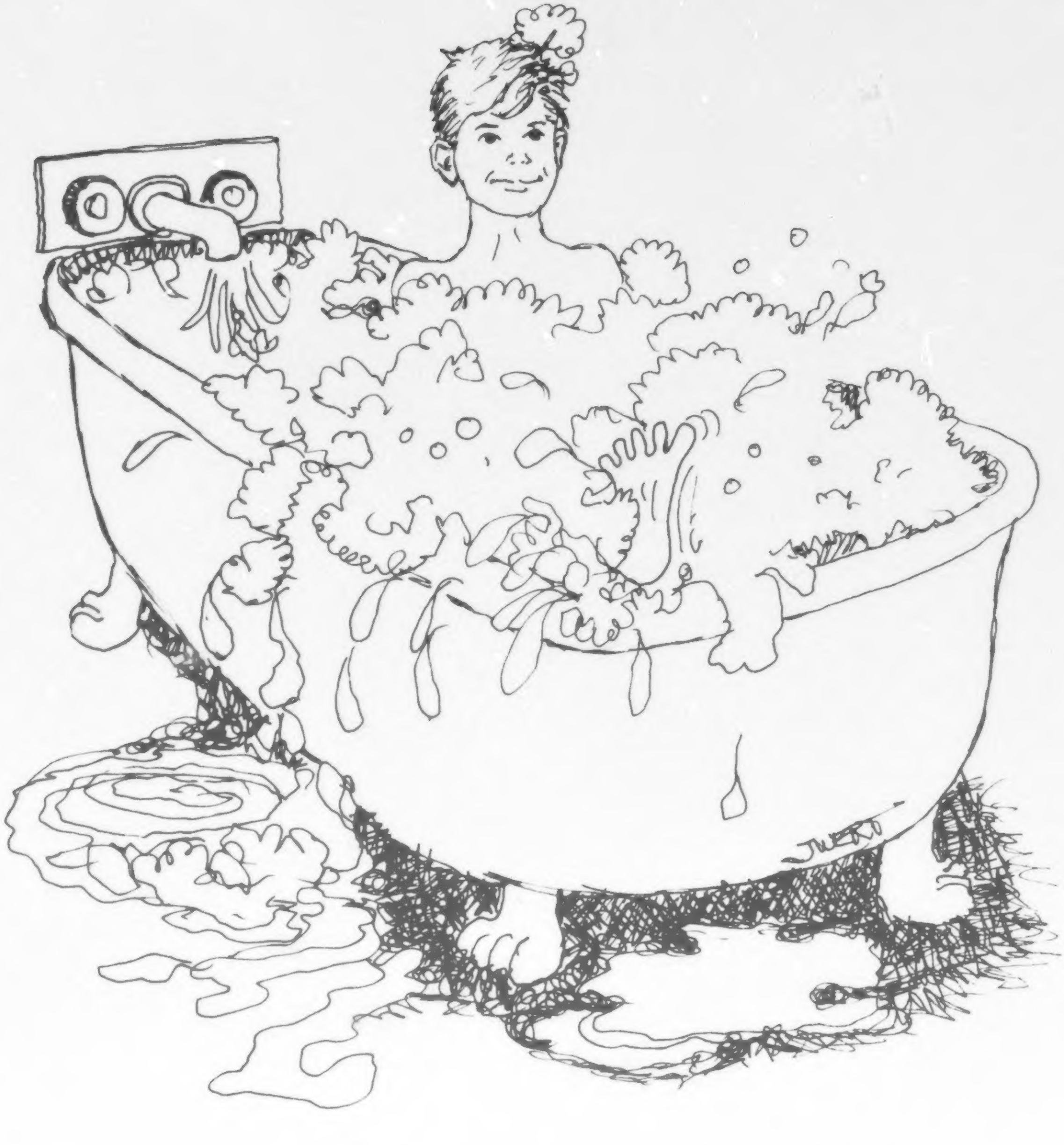
Radios and TVs should be turned off when no one is in the room.



ENERGY SAVER? ENERGY WASTER?

HINT:

This is a typical situation in many homes. Artifical light is used instead of natural light. Blinds should be raised to take advantage of the sunlight, and inside lights turned off.



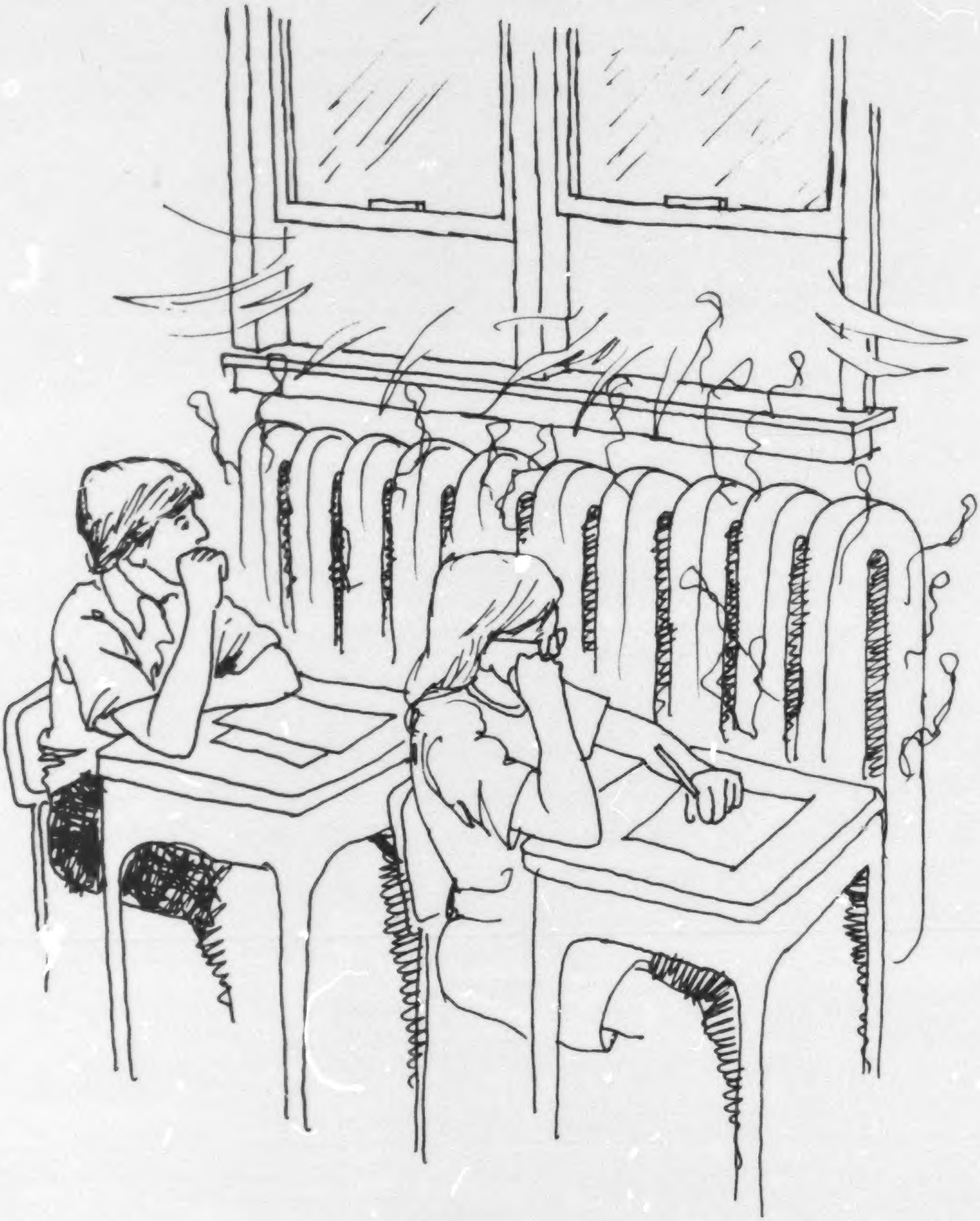
ENERGY SAVER? ENERGY WASTER?

HINTS:

An overflowing tub wastes hot water.

(a large percentage of the energy used in a household goes to heat water)

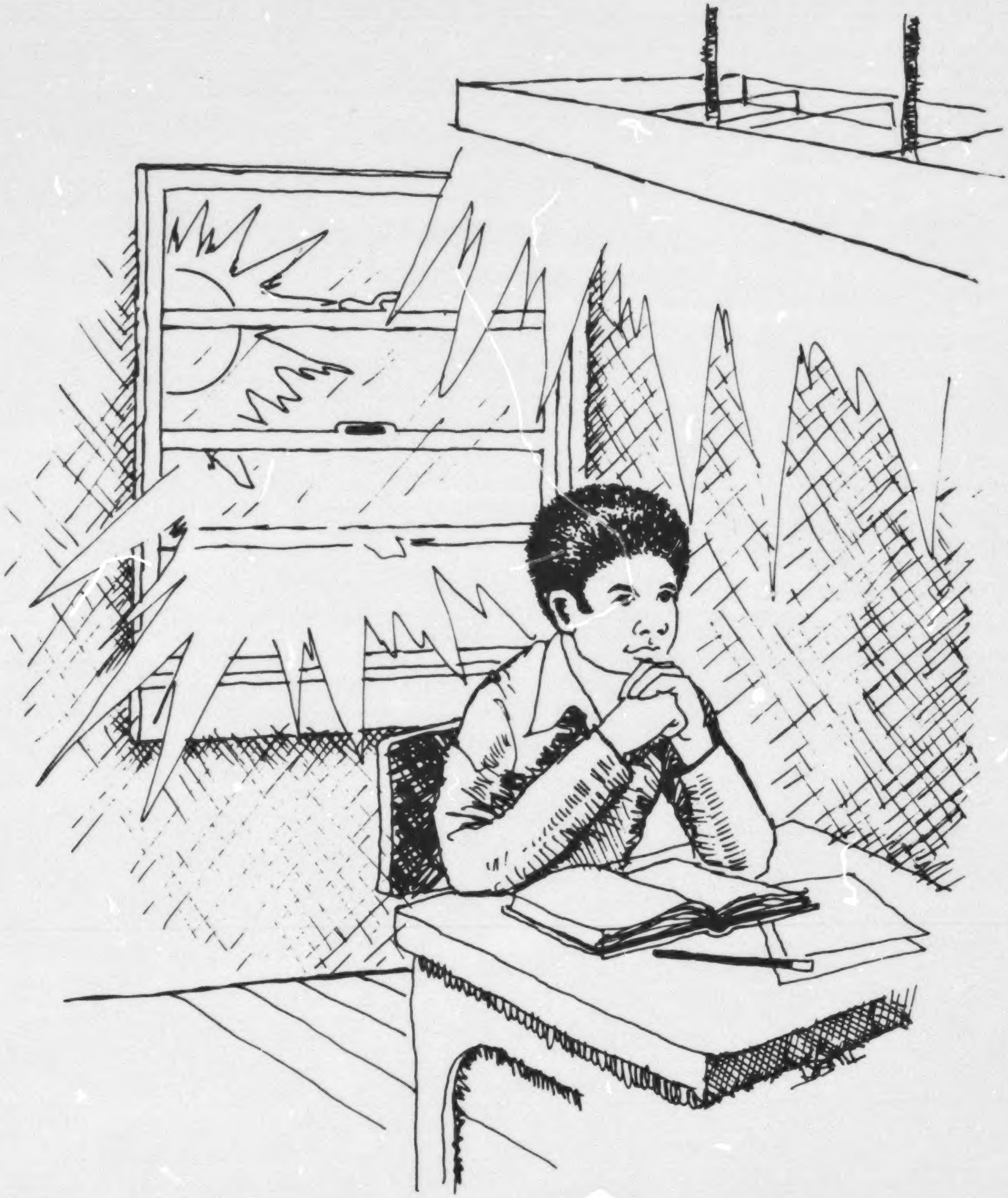
A quick shower maximizes energy efficiency.



ENERGY SAVER? **ENERGY WASTER?**

HINT:

The classroom is hot so the windows are open. It would be better to regulate the heat and keep the windows closed.



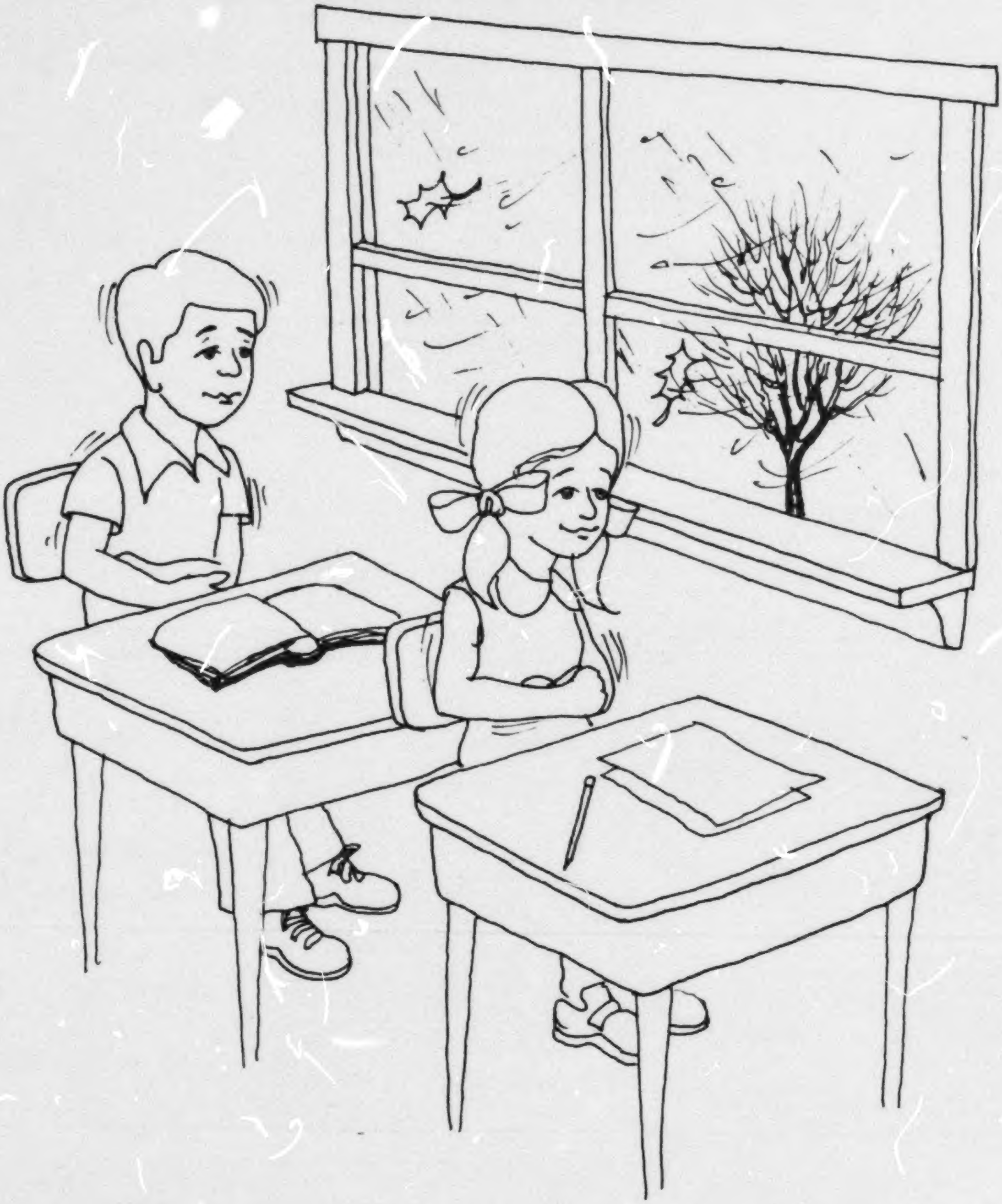
ENERGY SAVER?
1. ____________
2. ____________

ENERGY WASTER?
1. ____________
2. ____________

HINTS:

Lights are on nearest the window and are not needed on a sunny day.

Since the window is open, this classroom may be too warm, because the sun is providing thermal energy to heat the room.



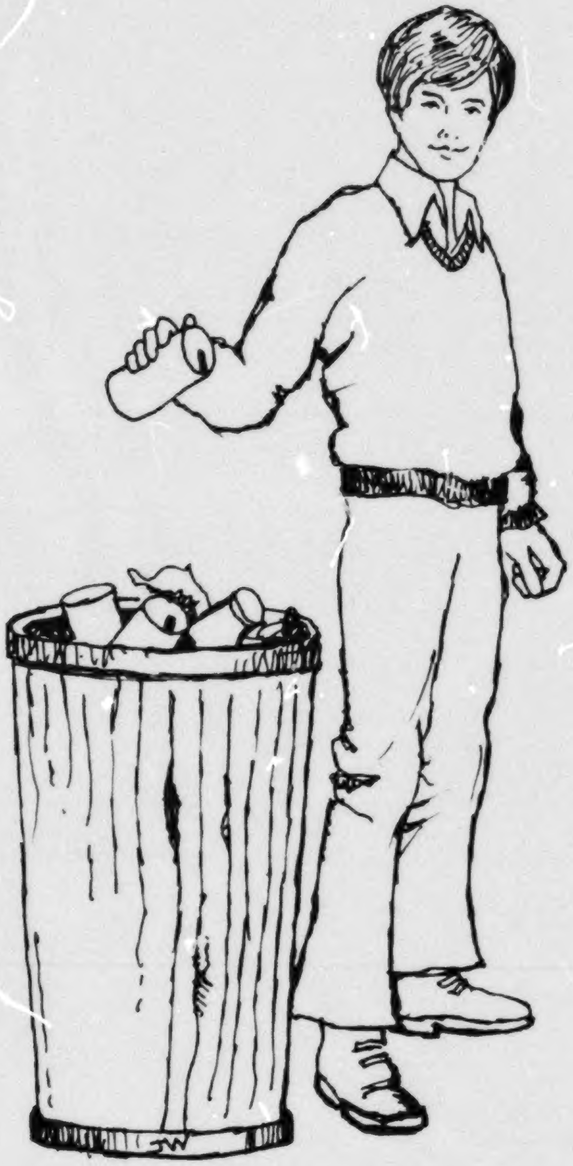
ENERGY SAVER? **ENERGY WASTER?**

HINTS:

These children did not wear warm clothes to school as they should when the school decided to save energy by turning down thermostats.

Frequent activity periods are needed in cooler atmospheres until body temperatures adjust.

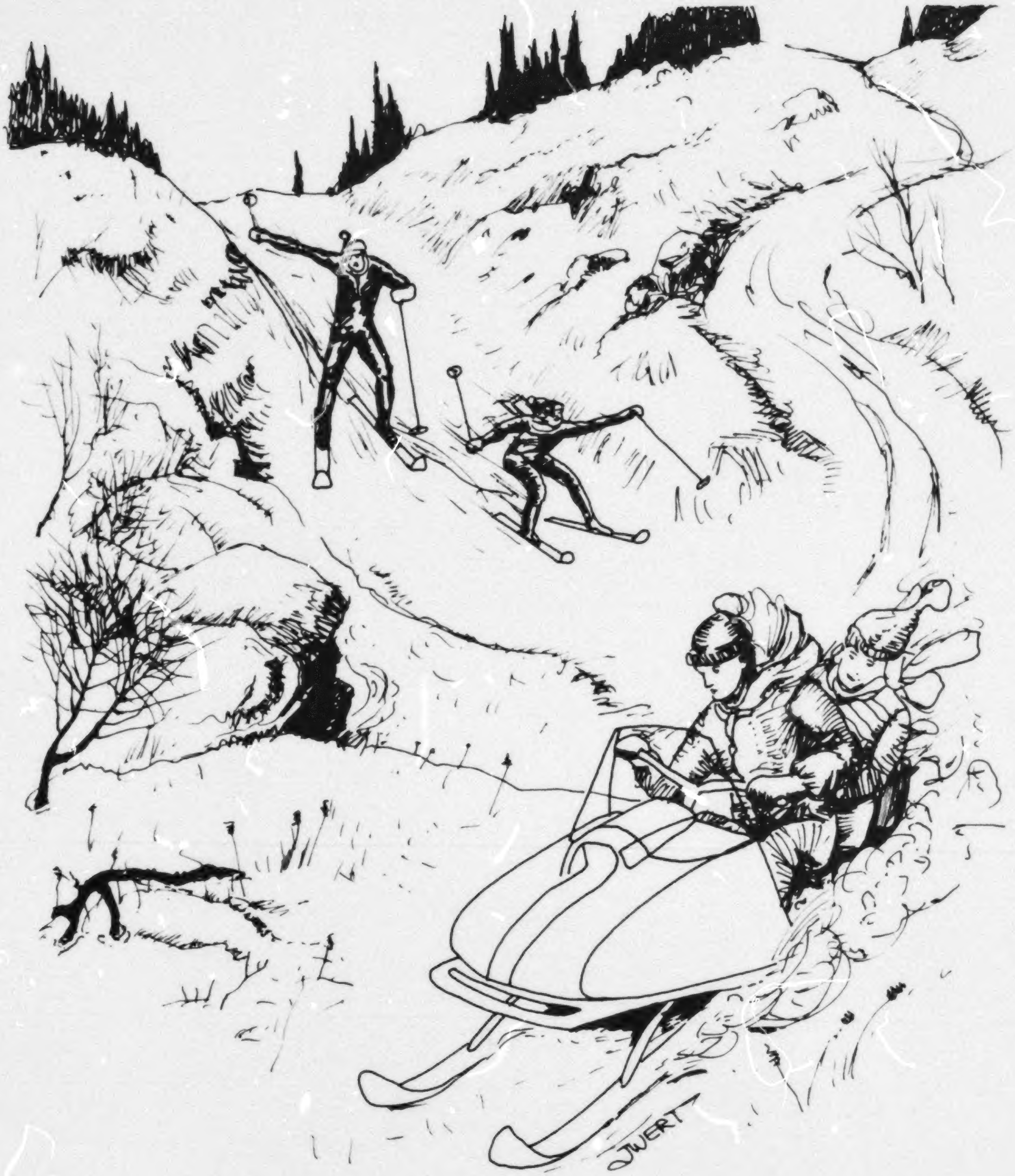
Hats and warm socks and shoes are important to keep in body heat.



ENERGY SAVER? **ENERGY WASTER?**

HINTS:

Although this boy is doing the right thing by throwing his can away, he could help save energy by drinking pop in returnable, refillable containers or aluminum cans which can then be recycled.



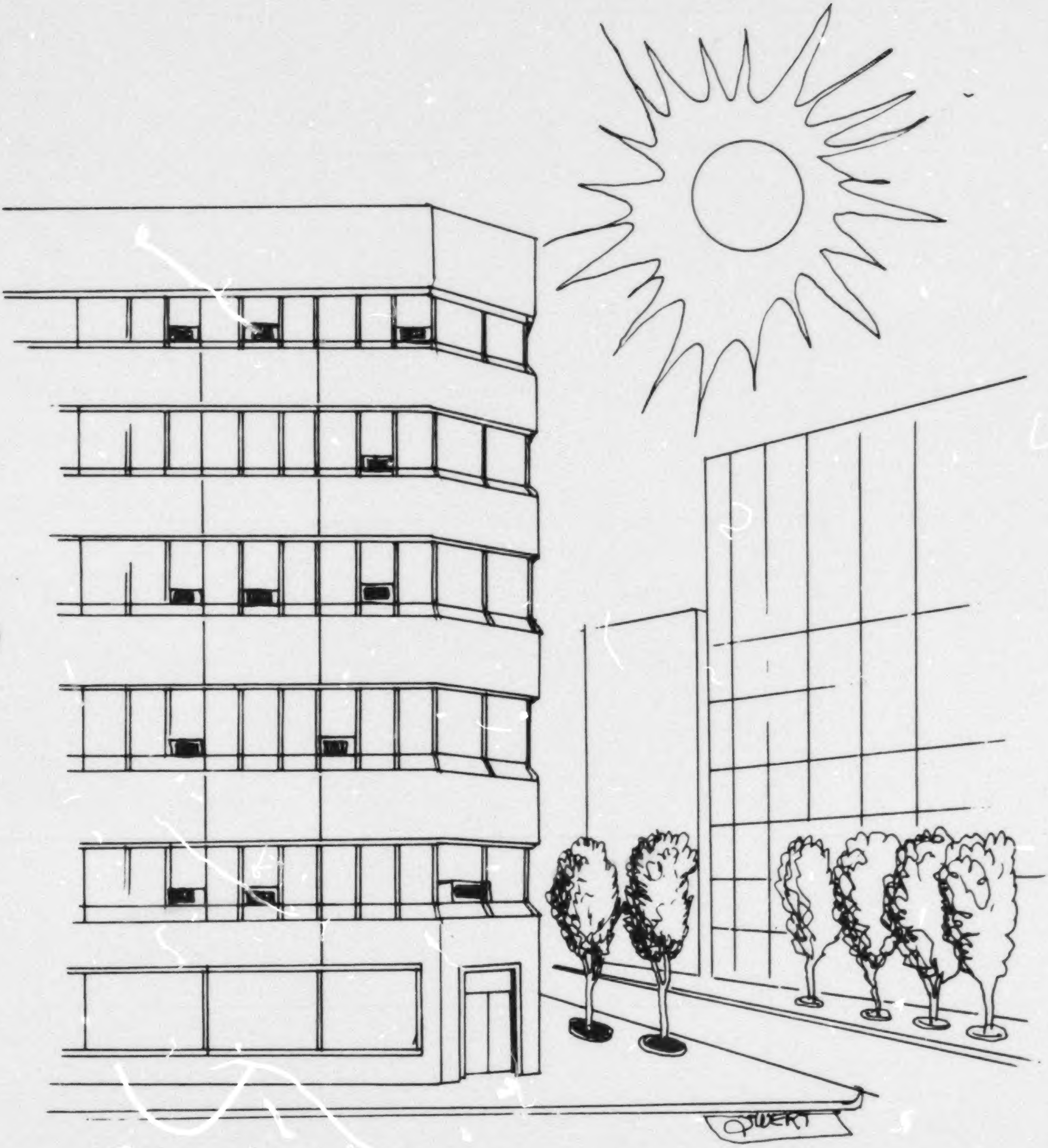
ENERGY SAVER? ENERGY WASTER?

HINTS:

If these children are down-hill skiing, they are using energy because of transportation to get to the ski area and energy used in ski lifts.

If they are cross-country skiing near home, they are saving energy.

Snowmobilers are using gasoline to power their vehicles.



ENERGY SAVER?   ENERGY WASTER?

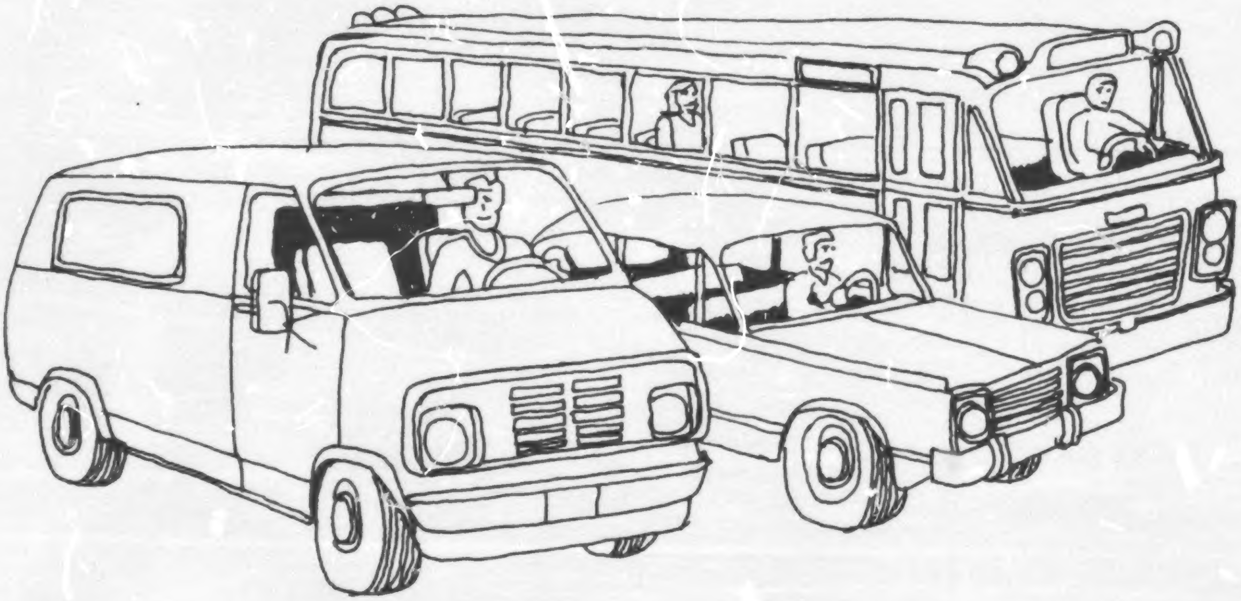
HINTS:

Cities are closed environments, and in the summer air conditioned buildings use a tremendous amount of energy.

Many office buildings can be designed to use heat from bodies and lights with windows which open for cross ventilation in the summer.

Setting thermostats to 78° will save energy in air conditioned office buildings.

Electric fans do not use as much energy as air conditioners.



ENERGY SAVER? **ENERGY WASTER?**

HINTS:

Almost every transportation vehicle in this illustration has only one passenger.

The camper is an energy eater!

Car pooling will conserve energy. So will riding the bus.

But those who are driving their cars are driving small cars, which are probably getting good gas mileage!

Grade Level: 6

Discipline: Science, Social Studies

Objective:

Students will compute the amount of money that one leaky hot water faucet costs in one year.

Suggested Time:

Materials Needed:

Measuring container (in fluid ounces or milliliters), a dripping faucet, booklet **Our Energy Problems and Solutions***

Teaching Suggestions:

Let a water faucet slowly drip cold water for exactly 15 minutes. Collect the drips in a measuring cup and then follow the steps outlined below. Measurements are shown in the metric system. For easy conversion, one fluid ounce equals about 30 ml.

Step 1: Multiply the number of ml of water by 4. (This gives the number of ml per hour leaking from the faucet.) _______ml

Step 2: Multiply the answer from Step 1 by 24. (This gives the number of ml per day leaking from the faucet.) _______ml/day

Step 3: Multiply the answer in Step 2 by 365. (This gives the number of ml lost per year.) _______ml/yr

Step 4: Divide the answer from Step 3 by 1000. (This gives the number of liters lost per year.) _______l/yr

Step 5: Assuming the water heater is electric, multiply the answer from Step 4 by 0.065. (This gives the approximate number of kilowatt hours of electricity used to heat the wasted water.) _______kwhr/yr

Step 6: Multiply the number from Step 5 by the rate that your electric company charges for one kilowatt hour. If no rate is available, use 6 cents per kilowatt hour, which is an average cost. _______

Step 6 gives the cost of one leaky hot water faucet for a year. Just imageine what the cost would be if there were more than one leaky hot water faucet.

*Available from: Energy Conservation Research
9 Birch Road
Malvern, PA 19355

Questions: Refer to pages 22-23 in the booklet **Our Energy Problems** and Solutions to answer the following questions.

1. How can a leaky water faucet be corrected/repaired?
   a. ______________________________
   b. ______________________________

2. The hot water heater is the ______________________ largest consumer of energy in the home.

3. Hot water must flow from the hot water tank in your basement to each faucet in the house. How can the energy released by the transfer through the pipes be minimized?__________ ______________________________

4. Why is it cheaper to take a shower instead of a bath in most cases?__________________ (You might try the test on page 23 of the booklet.)

5. Under what circumstances might it be cheaper to take a bath instead of a shower? ____

6. If your house has a dishwasher, the temperature of the hot water tank should be set at _____________degrees Celsius. Otherwise the temperature of the hot water tank could be set at ___________degrees Celsius.

7. When washing dishes, should hot or cold water be used to rinse them?_________________

8. What kind of water is used in the washing machine cycle in your home? Hot, cold, or a combination of both?________________________ Which type would be cheaper to use? ________________________________ reason do most people give for not washing all of their clothes in cold water?___________________________________

Grade Level: 4-6

Disciplines: Social Studies, Home Economics

Objective:

The students will discover ways to save energy in their homes.

Suggested Time: One class period

Materials Needed:

Activity master that follows

Teacher Notes:

Americans use 37 percent of the total energy used in this country for their residences and their automobiles. Of that figure, 40 percent is used in home heating and air conditioning, 6 percent for heating water, 4 percent for cooking, 4 percent for refrigeration, and 1 percent for lighting. Much of that energy is wasted or not used efficiently. Proper maintenance of equipment is a key factor in increasing efficiency. We have been hearing a lot about turning down thermostats to save money and energy, but there are other ways to save energy which have not been so sell publicized. Insulation of the attic to 6 inches and walls to 3 inches will help prevent heat loss. Carpeting on floors will save energy too. A clean house is also important: keeping dust away from heat vents, changing furnace filters, and cleaning windows to allow natural radiation to heat a home–all these will save energy. Repairing leaky faucets, taking showers instead of baths, using water-retarding shower heads to cut down on hot water use, and using cold water for washing clothes all reduce the energy used for heating water in the home. When decorating, choosing light colors and keeping furniture away from heat vents is important. Turning off lights when not in use, replacing incandescent bulbs with fluorescent, and using task lighting all conserve electricity used for lighting. Having a roaring fire in the fireplace can actually waste heat instead of adding heat to a home.

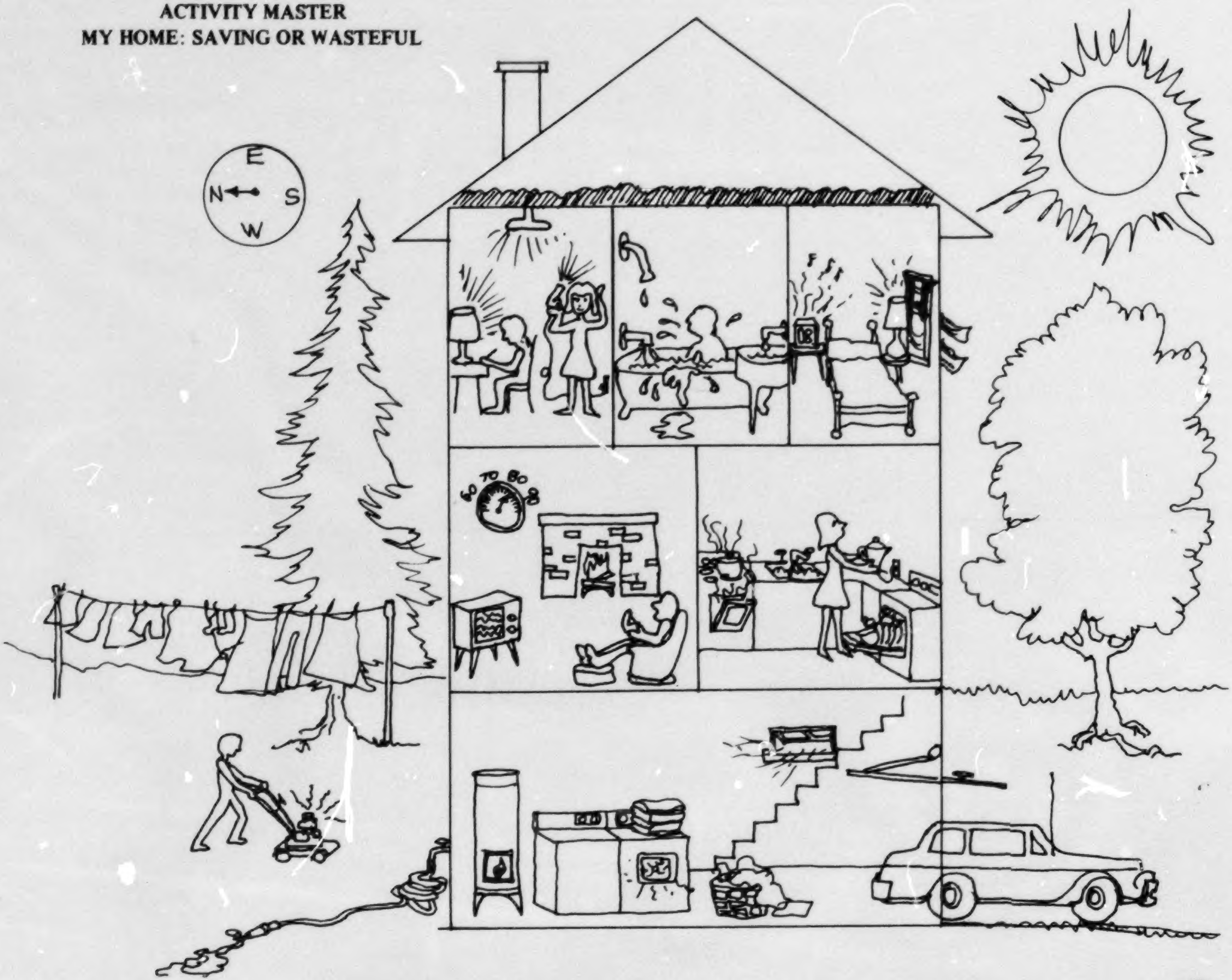
Teaching Suggestions:

Have the students put W for waste or S for save on the items in the activity master that follows. Discuss in class. The open window can be W or S depending on the time of year. Placing evergreen trees on the north side of a house will protect the home from the cold north wind in winter. A heat pump such as the one illustrated in the activity master is the most energy-efficient way of heating and cooling a home.

Discuss with the students the difference between using energy and wasting energy. See if the students can make conservation check lists for their own homes with the help of their parents.

by: Terry Webb
Conservation Consultants
Sewickley, PA

ACTIVITY MASTER
MY HOME: SAVING OR WASTEFUL


E
N
S
W
60 TO 80
18

Grade Level: Kindergarten and special ed (primary)

Disciplines: Health, Language Arts, Science

Objectives:

The students will recognize and demonstrate the proper kinds of clothing to wear to keep warm or to keep cool.
The students will practice buttoning, zipping, snapping, and tying when putting on the clothes.

Suggested Time 20-30 minutes

Materials Needed:

Flannel board, flannel board cutouts of thermostat, sun, wind, snow, boy and girl, clothing cutouts such as sweaters, hats, raincoats, mittens, warm socks, sleeveless light colored shirt, etc., manikins and actual clothing if available

Teacher Notes:

Schools and homeowners are being urged to keep homes and classrooms at 65-68 degrees in the winter to conserve our dwindling supplies of fossil fuels. During the summertime, we are being asked to keep our air conditioners set at higher temperatures (78 degrees) and to use air conditioners sparingly. Wearing the proper clothing can keep our bodies more comfortable at these temperatures. Children's metabolism functions better and can adjust to temperature changes more easily than adults.

Studies by the Army Natrick Development Center show that wearing layers of clothing helps to maintain proper body temperature in cold weather. These clothing rules allow proper ventilation and body temperature regulation in cold weather: keep it clean, avoid overheating, wear it loose, and keep it dry. Protecting the hands, feet, and head is also important to keep warm.

Wearing light colored clothes, short sleeves, and cotton fibers is a way to dress for comfort in warmer weather. Teaching children to dress properly for different seasons and temperatures will help them acclimatize to the energy conservation measures practiced by their families and school districts.

Teaching Suggestions:

Ask questions about the energy crisis: What is it? What do we have to do to help solve the crisis? Show a flannel board cutout of a thermostate set at 65 degrees and another set at 88 degrees. Discuss why thermostats are set at these temperatures. Lead into a discussion of the seasons of the year, what we do during these seasons, and the kinds of clothing we wear to be comfortable. Use flannel board cutouts to illustrate.

Using manikins of a boy and girl, ask the students to dress them according to the different seasons and the different temperature settings on the thermostats.

Additional Activities:

Use films and songs about the different seasons of the year and the activities associated with them.

Compose a class poem or play to share with other classes.

Grade Level: K-3

Discipline: **Health, Science, Language Arts**

Objectives:

The student will identify the proper color of clothing to wear in warm and in cold weather.

Suggested Time:

Materials Needed:

Pieces of white, black, green, red, and blue construction paper, all the same size, 5 uniformly-sized ice cubes, watch, clothing catalogues, poster paper, paste, activity master that follows

Teaching Suggestions:

Do the experiment which appears on the activity master that follows and discuss the results. Discuss the fact that dark colors absorb heat and light colors reflect heat. What does this mean in terms of the colors of clothes we should wear in the winter and in the summer?

Divide the class into 2 groups. Give one a fall-winter clothing or department store catalogue and the other a spring-summer catalogue. Have each group make a big collage poster of winter and summer clothes. Is there a noticeable color difference between the winter and summer clothes?

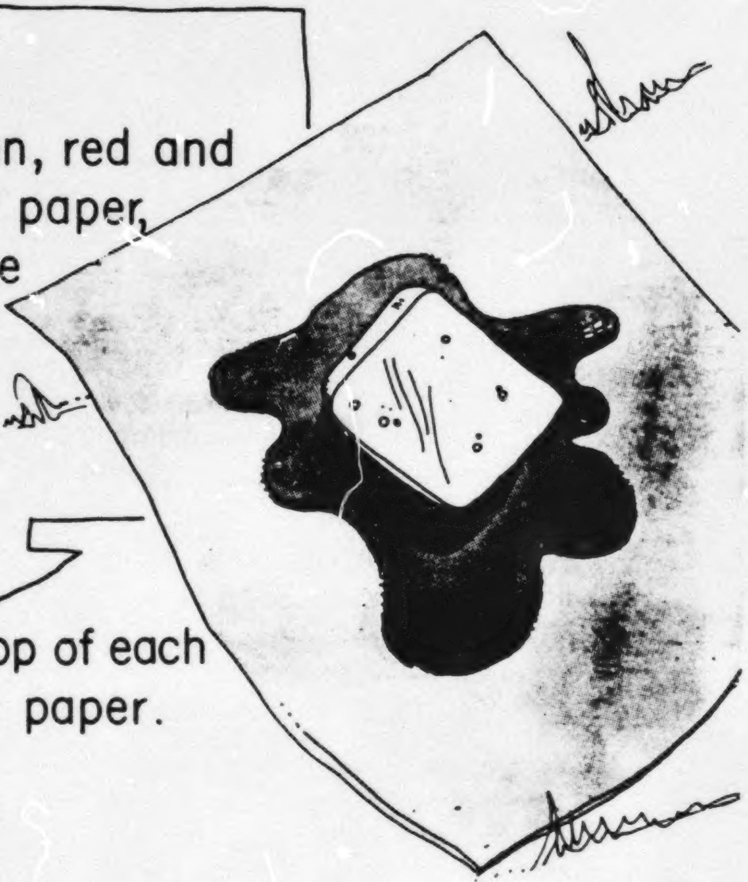
WHAT COLOR ABSORBS THE SUN'S HEAT BEST ?

MATERIALS:

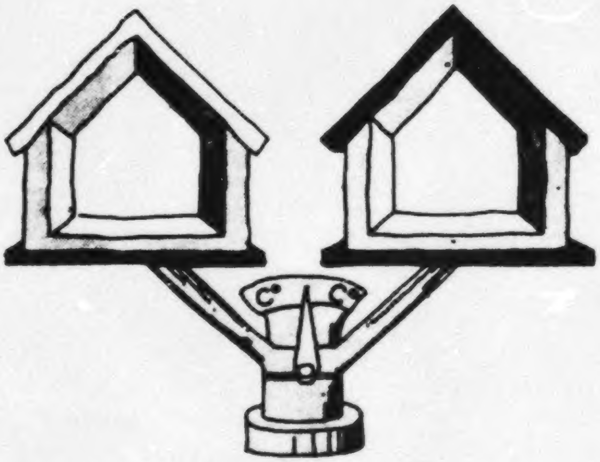
White, black, green, red and blue construction paper, all the same size

Timer

Uniformly-sized ice cubes

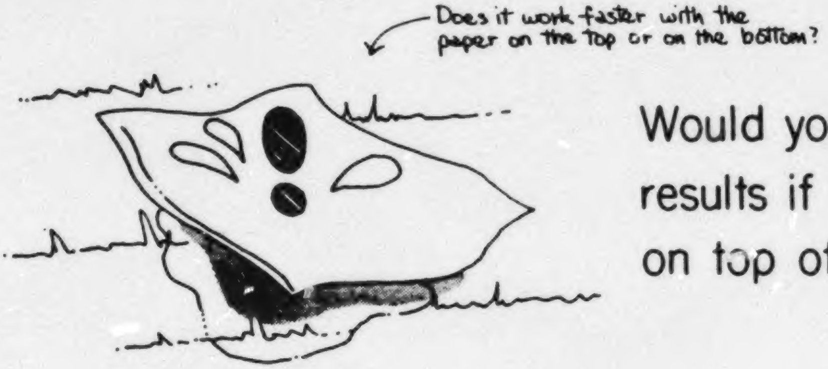


Place an ice cube on top of each sheet of construction paper. Which melts first?



Would a house with a white roof be cooler than a house with a dark roof?

OTHER IDEAS TO EXPLORE:


Does it work faster with the paper on the top or on the bottom?

Would you get the same results if the paper were on top of the ice cubes?

Would a house with a dark roof be more or less expensive to air-condition in the summertime?

Grade Level: 4-6

Discipline: Social Studies

Objective:

The students will examine their priorities for energy use.

Suggested Time: One class period

Materials Needed:

Chart on electricity usage that follows

Teacher Notes:

Every family and individual places a different priority on the electrical appliances needed to maintain a certain quality of life. It is not the teacher's role to determine which lifestyle is good or bad, but only to assist in developing the skills to make intelligent decisions in setting priorities for energy use.

Teaching Suggestions:

Give students the following scenario:

Imagine that your electric utility has told all the residents of your area that due to a serious energy supply problem, all its customers must cut back on their electric consumption by 1/3 during a week in July. List 13 electrical appliances your family uses every day. Cross out 3 appliances your family could do without. Circle 3 appliances they could not do without. Check the electrical consumption of the chosen appliances on the chart that follows. Have you chosen to give up appliances that use a lot of energy? Can you cut your electrical consumption by 1/3?

Have students discuss the appliances they chose. Were there any common ones they could not do without? What were their reasons for their choices?

ELECTRICAL USE OF APPLIANCES

	watts	monthly kwh used
frying pan	1150	16
barbeque grill	1350	5
sandwich grill	1160	3
rotisserie	1400	2
oven (electronic)	1450	22
coffee maker	900	6
clock	2	1
power saw	275	1
lawn mower	1500	3
sewing machine	75	1
vacuum cleaner	800	4
hedge trimmer	125	1
block heater	500	40
drill	300	1
furnance fan (oil or gas)	250	100
oil burner	260	50
radio (tube type)	50	8
radio solid state	5	1
hi-fi (tube type)	115	10
hi-fi solid state	50	6
TV Black & white	200	30
color	330	40
room air conditioner (6,000 BTu/hr)	935	60-400
room Air Condiitioner (9,000 BTu/hr)	1400	90-600
fan (portable)	115	4
hair dryer	350	3
heater (portable)	500-1500	
heating pad	65	1
dehumidifier	350	15
blanket	180	10
shaver	15	1
toothbrush	10	1
clothes dryer	4800	80
iron	1000	12
clothes washer	500	8
water heater	4500	500
carving knife	90	1
food blender	390	1
can opener	175	1
Lighting (incandescent)		
table lamp (3 way)	100	8
dining room fixture (5 lamp)	300	9
single ceiling fixture	60	2
(flourescent)		
4/ft single lamp	50	7
4/ft two lamps	100	15

Grade Level: 3-6

Discipline: Social Studies

Objective:

The students will solve Energy Conservation Picture Puzzles

Suggested Time: One class period

Materials Needed:

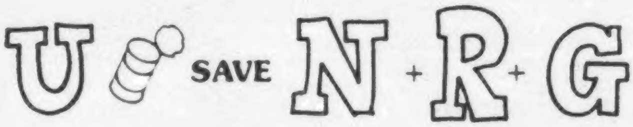
Puzzles that follow

Teaching Suggestions:

Have students solve the puzzles and make up one of their own as indicated.

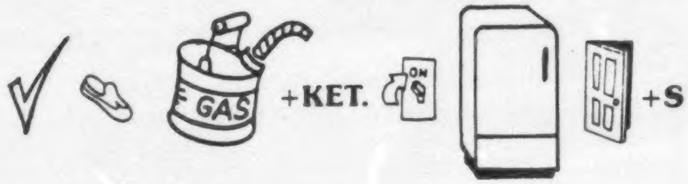
ACTIVITY SHEET : ENERGY CONSERVATION PICTURE PUZZLES

Here are ten picture puzzles, each containing an energy conservation tip. The example below shows how to solve the puzzles.



Example: You can save energy.

Developed by
Consolidated Edison



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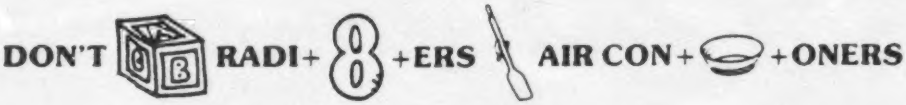
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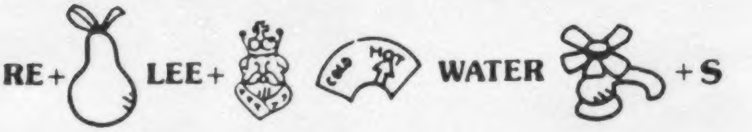
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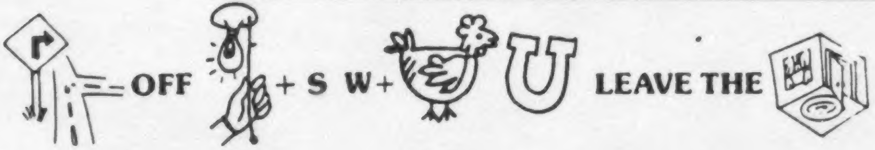
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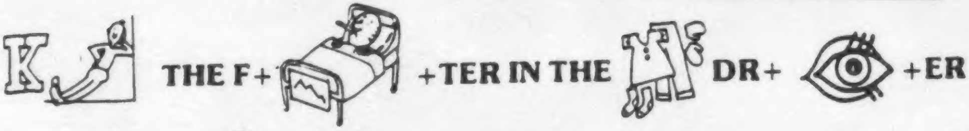
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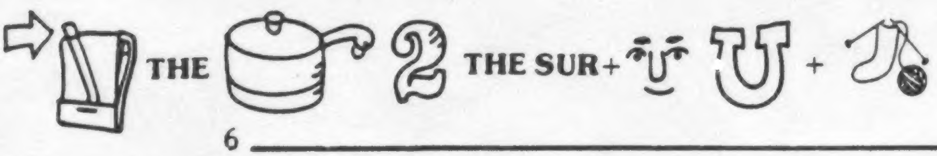
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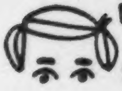
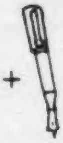
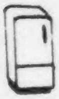
PLAN A+  B + 4 U O+  THE 

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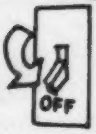
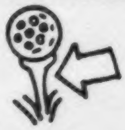
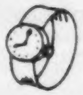
TURN   + V WHEN NO+ 1 IS  +ING

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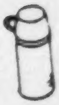
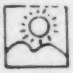
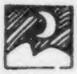
SET THE  +TAT AT 60 +8 DEGR+ EZ IN THE  AND LOWER AT 

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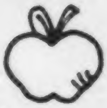
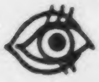
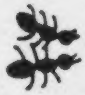
USE  +  +  + EZ ONLY 4 FULL LOADS

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Grade Level: 5, 6

Discipline: Language Arts, Social Studies

Objective:

Students will prepare a radio or TV script on energy conservation

Suggested Time:

Materials Needed:

Props for TV commercial, videotape equipment if available

Teaching Suggestions:

Have students create a one-minute radio or TV commercial dealing with some aspect of energy conservation. Have them present their commercials to the class. If you have videotape equipment available, tape the commercials and show them to the class. Discuss these questions: How many people does your commercial have to reach to change school or community attitudes? Who does your commercial have to convince?

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